# RESEARCH DEPARTMENT

TABLES OF HORIZONTAL RADIATION PATTERNS

OF DIPOLES MOUNTED ON CYLINDERS

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# THE BRITISH BROADCASTING
# CORPORATION
# ENGINEERING DIVISION

# TABLES OF HORIZONTAL RADIATION PATTERNS OF DIPOLES

# MOUNTED ON CYLINDERS

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SUMMARY

This report contains tables of the horizontal radiation pattern (h.r.p.) of a dipole mounted on a cylindrical mast. The tables were calculated on a digital computer and this enabled a comprehensive range of mast sizes and dipole spacings to be covered.

## 1. INTRODUCTION

Aerials used for v.h.f. broadcasting usually consist of tiers of dipoles mounted on a supporting mast. The number of dipoles in each tier and their relative positions and currents are determined by the required shape of the h.r.p. When an omnidirectional pattern is required, satisfactory results are generally obtained by using a number of dipoles uniformly spaced around the mast and fed symmetrically; in these cases it is convenient to calculate the pattern of the complete array, rather than that of an individual dipole. When a directional pattern is required, the procedure used in the theoretical design is to express the h.r.p. of a single dipole in the form of a complex number, the modulus corresponding to the amplitude of the radiated field and the argument to the phase referred to the axis of the mast. The h.r.p. of the arrangement of dipoles which seems most likely to satisfy the requirements is then calculated by adding the contributions from the individual dipoles. The result obtained will not necessarily be the most satisfactory h.r.p.; changes are therefore made to the dipole positions and currents and the calculation repeated until the best approximation to the required h.r.p. is obtained.

The calculation of the basic h.r.p. (that of a single dipole) is rather tedious, as it involves the summation of a complicated series of terms. A digital computer has, therefore, been used to assemble a library of such h.r.p.s, for dipoles having the three orientations shown in Fig. 1. Formulae for the radiation pattern of a doublet (i.e., a Hertzian dipole) mounted on a cylindrical mast have been derived by Carter,[1] and a brief description of his method, with notes on the application of his formulae to $\lambda/2$ dipoles, is contained in an earlier B.B.C. Research Department report.[2] Although cylindrical masts are not generally used by the B.B.C., the results obtained may be applied with little error to masts of other cross-sections provided their transverse dimensions are not too large.* Carter's formulae were used for the computations described in this report, approximations being made where necessary to obtain the result for dipoles rather than for doublets. The formulae and approximations used are described in the following section.

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*Carter's formulae may be used for square- and triangular-section masts having faces not exceeding $0.5\lambda$ and $0.3\lambda$ wide, respectively. The radius of the equivalent cylinder for a face of width w is 0.59w for masts of square section and 0.42w for masts of triangular section.
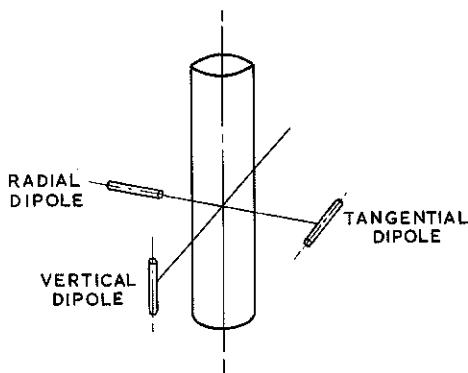
Fig. I - Types of dipoles

## 2. HORIZONTAL RADIATION PATTERN FORMULAE

The formulae for the h.r.p. of a dipole and cylinder given in this section are normalized both in amplitude and phase to the maximum field radiated if the cylinder were removed and the dipole replaced by a similarly oriented dipole, with its centre on the cylinder axis, carrying the same current. The symbols used in the formulae are defined as follows:

$A$ = mast radius in radians

$B$ = distance of dipole from axis of mast in radians

$\phi$ = azimuth angle, measured relative to the angular position of the centre of the dipole or unipole from the mast axis

$J_n(x)$ = Bessel function of the first kind, of order $n$ and argument $x$

$Y_n(x)$ = Bessel function of the second kind, of order $n$ and argument $x$

$H_n^{(2)}(x) = J_n(x) - j\,Y_n(x)$ (Hankel function of the second kind, of order $n$ and argument $x$)

$J_n'(x)$, $H_n^{(2)'}(x)$ denote the derivatives of $J_n(x)$, $H_n^{(2)}(x)$ with respect to $x$.

### 2.1. Vertical Dipoles

In the case of vertical elements, Carter's formula for a doublet is also applicable to a dipole. The series converges most rapidly when the contributions from the dipole and from the mast are calculated separately. The expression for the total field, stated in this form, is

$$E = e^{jB\cos\phi} + M_o + 2 \sum_{n=1}^{\infty} j^n M_n \cos n\phi$$

where

$$M_n = -J_n(A)\ \frac{H_n^{(2)}(B)}{H_n^{(2)}(A)}$$

## 2.2. Tangential Dipoles

Carter's formula for tangential doublets does not apply to tangential dipoles and some error will result if it is used. The error may be reduced by calculating the field radiated by the dipole directly; the doublet source is assumed only when calculating the contribution re-radiated by the mast. The appropriate formula for the total field is then

$$E = \frac{\cos(\frac{\pi}{2} \sin\phi)}{\cos\phi} \, e^{jB\cos\phi} - j \left[ M_0' + 2 \sum_{n=1}^{\infty} j^n M_n' \cos n\phi \right]$$

where

$$M_n' = -J_n'(A) \frac{H_n^{(2)}{}'(B)}{H_n^{(2)}{}'(A)}$$

This formula is similar to that used for vertical dipoles but the Bessel and Hankel functions are replaced by their derivatives.

## 2.3. Radial Dipoles and Unipoles

Arrays of radial elements used by the B.B.C. have invariably employed unipoles (or an electrical equivalent) mounted on the surface of the mast. The effective length is generally only $\lambda/4$ and it is therefore permissible to replace them by radial doublets located at the centroid* of the current distribution;[3] this enables Carter's formula to be used with little error. The most rapidly convergent form of the expression is

$$E = \sin\phi \, e^{jB\cos\phi} - j\frac{2}{B} \sum_{n=1}^{\infty} j^n \, n \, Z_n \, \sin n\phi$$

where

$$Z_n = -J_n'(A) \frac{H_n^{(2)}(B)}{H_n^{(2)}{}'(A)}$$

## 3. RANGE OF VALUES COMPUTED

Radiation patterns were computed for cylinder radii in the range 0·25 (0·25) 2·0 (0·5) 6·0 radians; this covers all the sizes of masts likely to be encountered in the foreseeable future. The smallest size of cylinder (radius 0·25 radians) corresponds to a 1 ft 9 in. (0·53 m) diameter pole at 45 Mc/s. Although smaller supporting poles are sometimes used, their effect is easily calculated because only the first term in the series expansion in the formulae quoted in Section 2 is then significant. The upper limit to the mast radius (6·0 radians or 0·96$\lambda$) corresponds to a mast diameter of about 10 ft (3·1 m) in Band III and about 3 ft (0·91 m) in Band V.

*We have to imagine that the unipole has a mass distributed along its length, the mass per unit length at any point being proportional to the current at that point. Then the centre of gravity (or centroid) of this mass would correspond to the centroid of the current distribution.

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This limit lies well above the range of sizes for which a cylindrical mast may be assumed as equivalent to a square- or triangular-section mast; the tables for the larger values of mast radius can therefore only be used for masts of circular, or nearly circular, cross-section.

For vertical and tangential dipoles, patterns were computed for dipoles spaced between 0·5 radians (0·08λ) and 4·0 radians (0·64λ) from the surface of the cylinder. For radial unipoles, patterns were computed for a doublet spacing of 0·5 radians only; this spacing corresponds very closely to the position of the current centroid of a λ/4 unipole. Calculations were made with these spacings for the chosen range of cylinder radii, making a total of 272 tables.

The real and imaginary components of the patterns are tabulated at $15^{\circ}$ intervals in the range $0 \leqslant \phi \leqslant 180^{\circ}$, the columns being headed R and I, respectively. Tabulation for the remaining $180^{\circ}$ was not necessary as the h.r.p.s are either symmetrical or skew-symmetrical (depending on the dipole orientation) with respect to the centre line. Each table is headed by V, T or R (vertical, tangential or radial) followed by the values of $A$ and $B$.

The computer programme was arranged to work through the whole range of variables without a break, the changes in the parameters $A$ and $B$ being made automatically. As these two parameters between them cover only a small number of radial distances, it was found to be more convenient to feed tabulated Bessel functions into the computer rather than use a time consuming sub-routine to calculate them. Bessel functions of the first and second kind, of zero and first order only, were stored in the computer; the higher order values were obtained from the recurrence formula, and their derivatives from the difference formula. Numerical values of $\cos \phi$ and $\sin \phi$ were also stored; only seven actual numbers were required, a special sub-routine being used to choose the appropriate value of $\cos \phi$ or $\sin \phi$ and give it the correct sign.

4. CONCLUSIONS

The tables of h.r.p.s should satisfy most requirements arising in the design of v.h.f. aerial systems for broadcast transmitters. Although applicable to cylindrical masts, they may be used with little error for masts of square or triangular cross-section provided the widths of the mast faces do not exceed 0·5λ and 0·3λ, respectively. The tables are intended not merely to give the pattern of a single dipole but also to simplify the calculation of the patterns of arrangements of more than one dipole spaced around a mast; this is achieved by appropriate addition of the contributions of each dipole and an analogue computer[4] has been developed in Research Department to facilitate this operation.

5. REFERENCES

1. Carter, P.S., "Antenna Arrays around Cylinders", Proc. I.R.E., Vol.31, No. 12, p. 671, December 1943.

2. "Methods of Calculating the Horizontal Radiation Patterns of Dipole Arrays Around a Support Mast", Research Department Report No.E-062, Serial No. 1958/10.

3. Medhurst, R. G., "Radiation from Short Aerials", Wireless Engineer, Vol.XXV, No. 299, p. 260, August 1948.

4. Research Department report in course of preparation.

MV

## CYLINDER RADIUS 0.25 RADIANS (0.04λ)

## VERTICAL DIPOLE

| V/A = 0.25, B = 0.75 | | |
|---|---|---|
| | R | I |
| 0 | +0.182 | +0.944 |
| 15 | +0.199 | +0.929 |
| 30 | +0.249 | +0.880 |
| 45 | +0.319 | +0.797 |
| 60 | +0.391 | +0.677 |
| 75 | +0.448 | +0.527 |
| 90 | +0.474 | +0.359 |
| 105 | +0.462 | +0.191 |
| 120 | +0.419 | +0.041 |
| 135 | +0.358 | -0.079 |
| 150 | +0.297 | -0.162 |
| 165 | +0.253 | -0.211 |
| 180 | +0.237 | -0.226 |

| V/A = 0.25, B = 1.25 | | |
|---|---|---|
| | R | I |
| 0 | +0.060 | +1.352 |
| 15 | +0.102 | +1.340 |
| 30 | +0.219 | +1.294 |
| 45 | +0.391 | +1.193 |
| 60 | +0.577 | +1.016 |
| 75 | +0.724 | +0.762 |
| 90 | +0.787 | +0.459 |
| 105 | +0.747 | +0.155 |
| 120 | +0.621 | -0.099 |
| 135 | +0.454 | -0.275 |
| 150 | +0.296 | -0.376 |
| 165 | +0.187 | -0.422 |
| 180 | +0.149 | -0.435 |

| V/A = 0.25, B = 1.75 | | |
|---|---|---|
| | R | I |
| 0 | -0.192 | +1.388 |
| 15 | -0.131 | +1.398 |
| 30 | -0.048 | +1.406 |
| 45 | +0.328 | +1.357 |
| 60 | +0.652 | +1.185 |
| 75 | +0.923 | +0.861 |
| 90 | +1.037 | +0.430 |
| 105 | +0.950 | -0.001 |
| 120 | +0.704 | -0.325 |
| 135 | +0.402 | -0.497 |
| 150 | +0.138 | -0.547 |
| 165 | -0.031 | -0.538 |
| 180 | -0.088 | -0.529 |

| V/A = 0.25, B = 2.25 | | |
|---|---|---|
| | R | I |
| 0 | -0.462 | +1.094 |
| 15 | -0.399 | +1.139 |
| 30 | -0.196 | +1.245 |
| 45 | +0.160 | +1.316 |
| 60 | +0.622 | +1.218 |
| 75 | +1.038 | +0.866 |
| 90 | +1.216 | +0.316 |
| 105 | +1.064 | -0.234 |
| 120 | +0.672 | -0.587 |
| 135 | +0.231 | -0.684 |
| 150 | -0.109 | -0.614 |
| 165 | -0.302 | -0.509 |
| 180 | -0.362 | -0.463 |

| V/A = 0.25, B = 2.75 | | |
|---|---|---|
| | R | I |
| 0 | -0.654 | +0.557 |
| 15 | -0.612 | +0.641 |
| 30 | -0.449 | +0.861 |
| 45 | -0.083 | +1.100 |
| 60 | +0.485 | +1.146 |
| 75 | +1.057 | +0.819 |
| 90 | +1.310 | +0.155 |
| 105 | +1.078 | -0.503 |
| 120 | +0.525 | -0.836 |
| 135 | -0.026 | -0.791 |
| 150 | -0.379 | -0.552 |
| 165 | -0.535 | -0.332 |
| 180 | -0.573 | -0.248 |

| V/A = 0.25, B = 3.25 | | |
|---|---|---|
| | R | I |
| 0 | -0.698 | -0.089 |
| 15 | -0.703 | -0.021 |
| 30 | -0.648 | +0.336 |
| 45 | -0.362 | +0.757 |
| 60 | +0.253 | +1.002 |
| 75 | +0.980 | +0.740 |
| 90 | +1.319 | +0.014 |
| 105 | +0.992 | -0.768 |
| 120 | +0.277 | -1.029 |
| 135 | -0.329 | -0.785 |
| 150 | -0.607 | -0.365 |
| 165 | -0.658 | -0.049 |
| 180 | -0.651 | +0.060 |

| V/A = 0.25, B = 3.75 | | |
|---|---|---|
| | R | I |
| 0 | -0.571 | -0.689 |
| 15 | -0.637 | -0.581 |
| 30 | -0.744 | -0.229 |
| 45 | -0.631 | +0.342 |
| 60 | -0.048 | +0.816 |
| 75 | +0.818 | +0.680 |
| 90 | +1.254 | -0.155 |
| 105 | +0.820 | -0.990 |
| 120 | -0.043 | -1.128 |
| 135 | -0.625 | -0.653 |
| 150 | -0.736 | -0.083 |
| 165 | -0.628 | +0.270 |
| 180 | -0.562 | +0.378 |

| V/A = 0.25, B = 4.25 | | |
|---|---|---|
| | R | I |
| 0 | -0.295 | -1.105 |
| 15 | -0.420 | -1.032 |
| 30 | -0.708 | -0.728 |
| 45 | -0.843 | -0.084 |
| 60 | -0.381 | +0.624 |
| 75 | +0.596 | +0.657 |
| 90 | +1.139 | -0.243 |
| 105 | +0.589 | -1.143 |
| 120 | -0.394 | -1.110 |
| 135 | -0.861 | -0.403 |
| 150 | -0.730 | +0.241 |
| 165 | -0.444 | +0.545 |
| 180 | -0.320 | +0.618 |

## VERTICAL DIPOLE

## CYLINDER RADIUS 0·5 RADIANS (0·08λ)

### A = 0·5, B = 1·0

| V | R | I |
|---|---|---|
| 0 | -0·132 | +0·935 |
| 15 | -0·103 | +0·926 |
| 30 | -0·020 | +0·892 |
| 45 | +0·099 | +0·824 |
| 60 | +0·228 | +0·711 |
| 75 | +0·334 | +0·554 |
| 90 | +0·391 | +0·369 |
| 105 | +0·386 | +0·185 |
| 120 | +0·327 | +0·027 |
| 135 | +0·240 | -0·087 |
| 150 | +0·153 | -0·157 |
| 165 | +0·090 | -0·192 |
| 180 | +0·068 | -0·202 |

### A = 0·5, B = 1·5

| V | R | I |
|---|---|---|
| 0 | -0·346 | +1·344 |
| 15 | -0·291 | +1·345 |
| 30 | -0·132 | +1·332 |
| 45 | +0·107 | +1·269 |
| 60 | +0·378 | +1·112 |
| 75 | +0·606 | +0·849 |
| 90 | +0·719 | +0·513 |
| 105 | +0·687 | +0·176 |
| 120 | +0·535 | -0·089 |
| 135 | +0·329 | -0·248 |
| 150 | +0·140 | -0·314 |
| 165 | +0·012 | -0·328 |
| 180 | -0·032 | -0·328 |

### A = 0·5, B = 2·0

| V | R | I |
|---|---|---|
| 0 | -0·574 | +1·344 |
| 15 | -0·506 | +1·373 |
| 30 | -0·298 | +1·432 |
| 45 | +0·044 | +1·445 |
| 60 | +0·462 | +1·314 |
| 75 | +0·831 | +0·985 |
| 90 | +1·008 | +0·507 |
| 105 | +0·924 | +0·029 |
| 120 | +0·641 | -0·304 |
| 135 | +0·297 | -0·438 |
| 150 | +0·013 | -0·429 |
| 165 | -0·160 | -0·373 |
| 180 | -0·215 | -0·345 |

### A = 0·5, B = 2·5

| V | R | I |
|---|---|---|
| 0 | -0·732 | +1·002 |
| 15 | -0·673 | +1·068 |
| 30 | -0·470 | +1·232 |
| 45 | -0·082 | +1·383 |
| 60 | +0·462 | +1·350 |
| 75 | +0·983 | +1·000 |
| 90 | +1·228 | +0·393 |
| 105 | +1·070 | -0·216 |
| 120 | +0·629 | -0·569 |
| 135 | +0·155 | -0·607 |
| 150 | -0·181 | -0·461 |
| 165 | -0·350 | -0·301 |
| 180 | -0·398 | -0·236 |

### A = 0·5, B = 3·0

| V | R | I |
|---|---|---|
| 0 | -0·756 | +0·429 |
| 15 | -0·732 | +0·527 |
| 30 | -0·606 | +0·796 |
| 45 | -0·254 | +1·120 |
| 60 | +0·365 | +1·250 |
| 75 | +1·037 | +0·935 |
| 90 | +1·356 | +0·213 |
| 105 | +1·103 | -0·511 |
| 120 | +0·491 | -0·831 |
| 135 | -0·076 | -0·706 |
| 150 | -0·388 | -0·387 |
| 165 | -0·489 | -0·122 |
| 180 | -0·504 | -0·026 |

### A = 0·5, B = 3·5

| V | R | I |
|---|---|---|
| 0 | -0·619 | -0·224 |
| 15 | -0·652 | -0·114 |
| 30 | -0·667 | +0·223 |
| 45 | -0·449 | +0·714 |
| 60 | +0·173 | +1·056 |
| 75 | +0·984 | +0·831 |
| 90 | +1·384 | +0·012 |
| 105 | +1·018 | -0·807 |
| 120 | +0·238 | -1·036 |
| 135 | -0·356 | -0·699 |
| 150 | -0·554 | -0·213 |
| 165 | -0·525 | +0·120 |
| 180 | -0·488 | +0·229 |

### A = 0·5, B = 4·0

| V | R | I |
|---|---|---|
| 0 | -0·338 | -0·797 |
| 15 | -0·434 | -0·705 |
| 30 | -0·632 | -0·373 |
| 45 | -0·633 | +0·233 |
| 60 | +0·097 | +0·809 |
| 75 | +0·830 | +0·730 |
| 90 | +1·320 | -0·163 |
| 105 | +0·830 | -1·058 |
| 120 | -0·097 | -1·140 |
| 135 | -0·634 | -0·568 |
| 150 | -0·632 | +0·034 |
| 165 | -0·435 | +0·363 |
| 180 | -0·338 | +0·454 |

### A = 0·5, B = 4·5

| V | R | I |
|---|---|---|
| 0 | +0·030 | -1·154 |
| 15 | -0·118 | -1·114 |
| 30 | -0·493 | -0·876 |
| 45 | -0·772 | -0·247 |
| 60 | -0·411 | +0·551 |
| 75 | +0·600 | +0·666 |
| 90 | +1·190 | -0·281 |
| 105 | +0·570 | -1·228 |
| 120 | -0·469 | -1·114 |
| 135 | -0·854 | -0·320 |
| 150 | -0·594 | +0·307 |
| 165 | -0·231 | +0·544 |
| 180 | -0·086 | +0·583 |

# VERTICAL DIPOLE

## CYLINDER RADIUS 0.75 RADIANS (0.12λ)

A = 0.75, B = 1.25

| V/A | R | I |
|---|---|---|
| 0 | −0.403 | +0.841 |
| 15 | −0.365 | +0.842 |
| 30 | −0.255 | +0.835 |
| 45 | −0.090 | +0.799 |
| 60 | +0.095 | +0.708 |
| 75 | +0.256 | +0.555 |
| 90 | +0.349 | +0.359 |
| 105 | +0.354 | +0.162 |
| 120 | +0.285 | +0.003 |
| 135 | +0.178 | −0.095 |
| 150 | +0.074 | −0.139 |
| 165 | −0.002 | −0.150 |
| 180 | −0.024 | −0.151 |

A = 0.75, B = 1.75

| V/A | R | I |
|---|---|---|
| 0 | −0.726 | +1.211 |
| 15 | −0.662 | +1.231 |
| 30 | −0.472 | +1.267 |
| 45 | −0.172 | +1.263 |
| 60 | +0.184 | +1.148 |
| 75 | +0.500 | +0.889 |
| 90 | +0.673 | +0.525 |
| 105 | +0.655 | +0.157 |
| 120 | +0.483 | −0.112 |
| 135 | +0.251 | −0.240 |
| 150 | +0.046 | −0.259 |
| 165 | −0.085 | −0.233 |
| 180 | −0.128 | −0.217 |

A = 0.75, B = 2.25

| V/A | R | I |
|---|---|---|
| 0 | −0.939 | +1.184 |
| 15 | −0.870 | +1.236 |
| 30 | −0.648 | +1.357 |
| 45 | −0.259 | +1.452 |
| 60 | +0.249 | +1.384 |
| 75 | +0.725 | +1.062 |
| 90 | +0.974 | +0.540 |
| 105 | +0.900 | +0.013 |
| 120 | +0.587 | −0.323 |
| 135 | +0.218 | −0.412 |
| 150 | −0.064 | −0.337 |
| 165 | −0.219 | −0.230 |
| 180 | −0.266 | −0.184 |

A = 0.75, B = 2.75

| V/A | R | I |
|---|---|---|
| 0 | −0.966 | +0.833 |
| 15 | −1.039 | +0.919 |
| 30 | −0.755 | +1.143 |
| 45 | −0.353 | +1.386 |
| 60 | +0.263 | +1.435 |
| 75 | +0.894 | +1.101 |
| 90 | +1.215 | +0.436 |
| 105 | +1.054 | −0.236 |
| 120 | +0.571 | −0.587 |
| 135 | +0.082 | −0.562 |
| 150 | −0.222 | −0.342 |
| 165 | −0.346 | −0.135 |
| 180 | −0.373 | −0.056 |

A = 0.75, B = 3.25

| V/A | R | I |
|---|---|---|
| 0 | −0.844 | +0.278 |
| 15 | −0.843 | +0.386 |
| 30 | −0.769 | +0.695 |
| 45 | −0.454 | +1.104 |
| 60 | +0.201 | +1.330 |
| 75 | +0.975 | +1.043 |
| 90 | +1.366 | +0.254 |
| 105 | +1.091 | −0.541 |
| 120 | +0.425 | −0.846 |
| 135 | −0.138 | −0.645 |
| 150 | −0.383 | −0.260 |
| 165 | −0.413 | +0.031 |
| 180 | −0.399 | +0.132 |

A = 0.75, B = 3.75

| V/A | R | I |
|---|---|---|
| 0 | −0.526 | −0.327 |
| 15 | −0.598 | −0.223 |
| 30 | −0.684 | +0.116 |
| 45 | −0.552 | +0.664 |
| 60 | +0.055 | +1.108 |
| 75 | +0.948 | +0.928 |
| 90 | +1.411 | +0.043 |
| 105 | +1.003 | −0.849 |
| 120 | +0.161 | −1.044 |
| 135 | −0.403 | −0.622 |
| 150 | −0.502 | −0.096 |
| 165 | −0.387 | +0.228 |
| 180 | −0.318 | +0.326 |

A = 0.75, B = 4.25

| V/A | R | I |
|---|---|---|
| 0 | −0.096 | −0.828 |
| 15 | −0.219 | −0.761 |
| 30 | −0.504 | −0.472 |
| 45 | −0.633 | +0.145 |
| 60 | −0.167 | +0.816 |
| 75 | +0.814 | +0.802 |
| 90 | +1.357 | −0.151 |
| 105 | +0.803 | −1.108 |
| 120 | −0.186 | −1.133 |
| 135 | −0.662 | −0.478 |
| 150 | −0.541 | +0.124 |
| 165 | −0.261 | +0.401 |
| 180 | −0.139 | +0.465 |

A = 0.75, B = 4.75

| V/A | R | I |
|---|---|---|
| 0 | +0.357 | −1.103 |
| 15 | +0.193 | −1.102 |
| 30 | −0.253 | −0.953 |
| 45 | −0.678 | −0.370 |
| 60 | −0.439 | +0.502 |
| 75 | +0.592 | +0.705 |
| 90 | +1.226 | −0.287 |
| 105 | +0.526 | −1.281 |
| 120 | −0.566 | −1.083 |
| 135 | −0.858 | −0.219 |
| 150 | −0.475 | +0.357 |
| 165 | −0.055 | +0.501 |
| 180 | +0.099 | +0.500 |

VERTICAL DIPOLE

CYLINDER RADIUS 1.0 RADIANS (0.16λ)

$V/A = 1.0$, $B = 1.5$

| Angle | R | I |
|---|---|---|
| 0 | -0.626 | +0.686 |
| 15 | -0.583 | +0.701 |
| 30 | -0.455 | +0.733 |
| 45 | -0.256 | +0.743 |
| 60 | -0.022 | +0.688 |
| 75 | +0.190 | +0.547 |
| 90 | +0.319 | +0.342 |
| 105 | +0.335 | +0.131 |
| 120 | +0.258 | -0.026 |
| 135 | +0.138 | -0.104 |
| 150 | +0.027 | -0.118 |
| 165 | -0.045 | -0.103 |
| 180 | -0.069 | -0.094 |

$V/A = 1.0$, $B = 2.0$

| Angle | R | I |
|---|---|---|
| 0 | -1.047 | +0.983 |
| 15 | -0.982 | +1.025 |
| 30 | -0.777 | +1.124 |
| 45 | -0.436 | +1.199 |
| 60 | -0.005 | +1.149 |
| 75 | +0.398 | +0.909 |
| 90 | +0.632 | +0.521 |
| 105 | +0.628 | +0.122 |
| 120 | +0.439 | -0.150 |
| 135 | +0.190 | -0.243 |
| 150 | -0.012 | -0.210 |
| 165 | -0.129 | -0.143 |
| 180 | -0.166 | -0.112 |

$V/A = 1.0$, $B = 2.5$

| Angle | R | I |
|---|---|---|
| 0 | -1.247 | +0.928 |
| 15 | -1.184 | +1.004 |
| 30 | -0.969 | +1.197 |
| 45 | -0.556 | +1.393 |
| 60 | +0.029 | +1.413 |
| 75 | +0.610 | +1.117 |
| 90 | +0.934 | +0.555 |
| 105 | +0.869 | -0.022 |
| 120 | +0.527 | -0.360 |
| 135 | +0.147 | -0.399 |
| 150 | -0.111 | -0.261 |
| 165 | -0.229 | -0.111 |
| 180 | -0.259 | -0.050 |

$V/A = 1.0$, $B = 3.0$

| Angle | R | I |
|---|---|---|
| 0 | -1.194 | +0.595 |
| 15 | -1.163 | +0.699 |
| 30 | -1.015 | +0.985 |
| 45 | -0.626 | +1.332 |
| 60 | +0.046 | +1.485 |
| 75 | +0.787 | +1.186 |
| 90 | +1.187 | +0.467 |
| 105 | +1.021 | -0.269 |
| 120 | +0.496 | -0.617 |
| 135 | +0.008 | -0.529 |
| 150 | -0.242 | -0.248 |
| 165 | -0.304 | -0.010 |
| 180 | -0.305 | +0.077 |

$V/A = 1.0$, $B = 3.5$

| Angle | R | I |
|---|---|---|
| 0 | -0.897 | +0.102 |
| 15 | -0.922 | +0.214 |
| 30 | -0.914 | +0.555 |
| 45 | -0.657 | +1.048 |
| 60 | +0.016 | +1.386 |
| 75 | +0.889 | +1.144 |
| 90 | +1.355 | +0.294 |
| 105 | +1.056 | -0.574 |
| 120 | +0.336 | -0.862 |
| 135 | -0.207 | -0.588 |
| 150 | -0.368 | -0.159 |
| 165 | -0.317 | +0.135 |
| 180 | -0.272 | +0.230 |

$V/A = 1.0$, $B = 4.0$

| Angle | R | I |
|---|---|---|
| 0 | +0.419 | -0.407 |
| 15 | -0.508 | -0.318 |
| 30 | -0.685 | +0.008 |
| 45 | -0.655 | +0.599 |
| 60 | -0.080 | +1.149 |
| 75 | +0.890 | +1.029 |
| 90 | +1.420 | +0.081 |
| 105 | +0.964 | -0.881 |
| 120 | +0.061 | -1.039 |
| 135 | -0.460 | -0.542 |
| 150 | -0.451 | -0.003 |
| 165 | -0.251 | +0.284 |
| 180 | -0.154 | +0.359 |

$V/A = 1.0$, $B = 4.5$

| Angle | R | I |
|---|---|---|
| 0 | +0.140 | -0.798 |
| 15 | -0.004 | -0.762 |
| 30 | -0.366 | -0.539 |
| 45 | -0.625 | +0.065 |
| 60 | -0.244 | +0.823 |
| 75 | +0.783 | +0.887 |
| 90 | +1.382 | +0.122 |
| 105 | +0.760 | -1.141 |
| 120 | -0.291 | -1.101 |
| 135 | -0.696 | -0.376 |
| 150 | -0.457 | +0.194 |
| 165 | -0.110 | +0.393 |
| 180 | +0.029 | +0.420 |

$V/A = 1.0$, $B = 5.0$

| Angle | R | I |
|---|---|---|
| 0 | +0.655 | -0.970 |
| 15 | +0.487 | -1.012 |
| 30 | -0.007 | -0.971 |
| 45 | -0.567 | -0.466 |
| 60 | -0.463 | +0.462 |
| 75 | +0.580 | +0.761 |
| 90 | +1.261 | -0.274 |
| 105 | +0.475 | -1.312 |
| 120 | -0.668 | -1.021 |
| 135 | -0.859 | -0.102 |
| 150 | -0.369 | +0.392 |
| 165 | +0.080 | +0.426 |
| 180 | +0.232 | +0.381 |

CYLINDER RADIUS 1·25 RADIANS (0·20λ)

VERTICAL DIPOLE

A = 1·25

| V/A | B = 1·75 R | B = 1·75 I | B = 2·25 R | B = 2·25 I | B = 2·75 R | B = 2·75 I | B = 3·25 R | B = 3·25 I |
|---|---|---|---|---|---|---|---|---|
| 0   | -0·789 | +0·486 | -1·288 | +0·677 | -1·473 | +0·592 | -1·332 | +0·300 |
| 15  | -0·747 | +0·517 | -1·228 | +0·745 | -1·425 | +0·694 | -1·326 | +0·420 |
| 30  | -0·617 | +0·594 | -1·032 | +0·915 | -1·240 | +0·963 | -1·234 | +0·763 |
| 45  | -0·400 | +0·662 | -0·673 | +1·088 | -0·831 | +1·276 | -0·884 | +1·221 |
| 60  | -0·127 | +0·657 | -0·184 | +1·124 | -0·189 | +1·408 | -0·175 | +1·502 |
| 75  | +0·132 | +0·538 | +0·300 | +0·920 | +0·493 | +1·160 | +0·671 | +1·260 |
| 90  | +0·294 | +0·326 | +0·592 | +0·514 | +0·891 | +0·566 | +1·152 | +0·496 |
| 105 | +0·318 | +0·101 | +0·598 | +0·082 | +0·830 | -0·061 | +0·976 | -0·303 |
| 120 | +0·231 | -0·057 | +0·391 | -0·191 | +0·458 | -0·399 | +0·408 | -0·642 |
| 135 | +0·104 | -0·114 | +0·134 | -0·249 | +0·076 | -0·389 | -0·070 | -0·495 |
| 150 | -0·002 | -0·097 | -0·050 | -0·169 | -0·140 | -0·198 | -0·250 | -0·170 |
| 165 | -0·064 | -0·059 | -0·138 | -0·067 | -0·207 | -0·018 | -0·240 | +0·077 |
| 180 | -0·083 | -0·042 | -0·161 | -0·025 | -0·214 | +0·050 | -0·213 | +0·161 |

| V/A | B = 3·75 R | B = 3·75 I | B = 4·25 R | B = 4·25 I | B = 4·75 R | B = 4·75 I | B = 5·25 R | B = 5·25 I |
|---|---|---|---|---|---|---|---|---|
| 0   | -0·909 | -0·093 | -0·303 | -0·466 | +0·350 | -0·712 | +0·901 | -0·763 |
| 15  | -0·962 | +0·018 | -0·416 | -0·397 | +0·195 | -0·714 | +0·742 | -0·851 |
| 30  | -1·029 | +0·376 | -0·670 | -0·106 | -0·225 | -0·576 | +0·229 | -0·933 |
| 45  | -0·850 | +0·949 | -0·751 | +0·511 | -0·610 | -0·014 | -0·447 | -0·539 |
| 60  | -0·178 | +1·413 | -0·224 | +1·171 | -0·328 | +0·822 | -0·486 | +0·424 |
| 75  | +0·792 | +1·239 | +0·821 | +1·129 | +0·743 | +0·975 | +0·564 | +0·821 |
| 90  | +1·338 | +0·335 | +1·424 | +0·126 | +1·405 | -0·085 | +1·298 | -0·253 |
| 105 | +1·008 | -0·601 | +0·916 | -0·904 | +0·711 | -1·159 | +0·425 | -1·327 |
| 120 | +0·234 | -0·866 | +0·048 | -1·015 | -0·397 | -1·046 | -0·760 | -0·934 |
| 135 | -0·281 | -0·526 | -0·516 | -0·450 | -0·722 | -0·261 | -0·845 | +0·025 |
| 150 | -0·348 | -0·076 | -0·399 | -0·072 | -0·377 | +0·249 | -0·270 | +0·416 |
| 165 | -0·216 | +0·193 | -0·128 | +0·295 | +0·012 | +0·350 | +0·175 | +0·332 |
| 180 | -0·142 | +0·271 | -0·010 | +0·339 | +0·155 | +0·334 | +0·310 | +0·244 |

VERTICAL DIPOLE

CYLINDER RADIUS 1.5 RADIANS (0.24λ)

V  A = 1.5  B = 2.0

| | R | I |
|---|---|---|
| 0 | -0.890 | +0.253 |
| 15 | -0.855 | +0.302 |
| 30 | -0.737 | +0.427 |
| 45 | -0.520 | +0.562 |
| 60 | -0.221 | +0.617 |
| 75 | +0.079 | +0.528 |
| 90 | +0.272 | +0.314 |
| 105 | +0.301 | +0.074 |
| 120 | +0.203 | -0.084 |
| 135 | +0.072 | -0.121 |
| 150 | -0.022 | -0.080 |
| 165 | -0.065 | -0.023 |
| 180 | -0.075 | +0.000 |

V  A = 1.5  B = 2.5

| | R | I |
|---|---|---|
| 0 | -1.435 | +0.318 |
| 15 | -1.391 | +0.410 |
| 30 | -1.225 | +0.653 |
| 45 | -0.876 | +0.936 |
| 60 | -0.349 | +1.077 |
| 75 | +0.208 | +0.926 |
| 90 | +0.557 | +0.508 |
| 105 | +0.568 | +0.045 |
| 120 | +0.338 | -0.227 |
| 135 | +0.079 | -0.251 |
| 150 | -0.075 | -0.132 |
| 165 | -0.124 | -0.009 |
| 180 | -0.130 | +0.039 |

V  A = 1.5  B = 3.0

| | R | I |
|---|---|---|
| 0 | -1.602 | +0.203 |
| 15 | -1.578 | +0.326 |
| 30 | -1.447 | +0.668 |
| 45 | -1.072 | +1.105 |
| 60 | -0.397 | +1.372 |
| 75 | +0.379 | +1.193 |
| 90 | +0.851 | +0.576 |
| 105 | +0.789 | -0.097 |
| 120 | +0.382 | -0.430 |
| 135 | +0.004 | -0.373 |
| 150 | -0.158 | -0.145 |
| 165 | -0.165 | +0.045 |
| 180 | -0.148 | +0.113 |

V  A = 1.5  B = 3.5

| | R | I |
|---|---|---|
| 0 | -1.393 | -0.031 |
| 15 | -1.415 | +0.099 |
| 30 | -1.397 | +0.489 |
| 45 | -1.114 | +1.058 |
| 60 | -0.393 | +1.483 |
| 75 | +0.554 | +1.322 |
| 90 | +1.119 | +0.525 |
| 105 | +0.928 | -0.332 |
| 120 | +0.313 | -0.656 |
| 135 | -0.147 | -0.452 |
| 150 | -0.250 | -0.103 |
| 165 | -0.168 | +0.128 |
| 180 | -0.113 | +0.199 |

V  A = 1.5  B = 4.0

| | R | I |
|---|---|---|
| 0 | -0.878 | -0.295 |
| 15 | -0.958 | -0.193 |
| 30 | -1.105 | +0.168 |
| 45 | -1.024 | +0.808 |
| 60 | -0.374 | +1.408 |
| 75 | +0.689 | +1.322 |
| 90 | +1.320 | +0.376 |
| 105 | +0.958 | -0.623 |
| 120 | +0.128 | -0.854 |
| 135 | -0.350 | -0.451 |
| 150 | -0.323 | -0.005 |
| 165 | -0.120 | +0.213 |
| 180 | -0.024 | +0.264 |

V  A = 1.5  B = 4.5

| | R | I |
|---|---|---|
| 0 | -0.185 | 0.500 |
| 15 | -0.316 | -0.459 |
| 30 | -0.638 | -0.220 |
| 45 | -0.836 | +0.401 |
| 60 | -0.373 | +1.169 |
| 75 | +0.744 | +1.221 |
| 90 | +1.427 | +0.170 |
| 105 | +0.866 | -0.919 |
| 120 | -0.155 | -0.972 |
| 135 | -0.562 | -0.346 |
| 150 | -0.347 | +0.136 |
| 165 | -0.025 | +0.274 |
| 180 | +0.102 | +0.279 |

V  A = 1.5  B = 5.0

| | R | I |
|---|---|---|
| 0 | +0.522 | -0.578 |
| 15 | +0.367 | -0.621 |
| 30 | -0.089 | -0.584 |
| 45 | -0.590 | -0.093 |
| 60 | -0.416 | +0.808 |
| 75 | +0.696 | +1.058 |
| 90 | +1.428 | +0.047 |
| 105 | +0.663 | -0.170 |
| 120 | -0.495 | -0.970 |
| 135 | -0.732 | -0.135 |
| 150 | -0.300 | +0.293 |
| 165 | +0.101 | +0.285 |
| 180 | +0.234 | +0.226 |

V  A = 1.5  B = 5.5

| | R | I |
|---|---|---|
| 0 | +1.079 | -0.499 |
| 15 | +0.942 | -0.631 |
| 30 | +0.443 | -0.843 |
| 45 | -0.325 | -0.589 |
| 60 | -0.510 | +0.383 |
| 75 | +0.542 | +0.880 |
| 90 | +1.336 | -0.230 |
| 105 | +0.379 | -1.336 |
| 120 | -0.836 | -0.830 |
| 135 | -0.808 | +0.157 |
| 150 | -0.176 | +0.429 |
| 165 | +0.230 | +0.231 |
| 180 | +0.334 | +0.105 |

# VERTICAL DIPOLE

## CYLINDER RADIUS 1·75 RADIANS (0·28λ)

V, A = 1·75, B = 2·25

| V | R | I |
|---|---|---|
| 0 | -0·925 | +0·007 |
| 15 | -0·902 | +0·071 |
| 30 | -0·812 | +0·241 |
| 45 | -0·614 | +0·444 |
| 60 | -0·304 | +0·568 |
| 75 | +0·032 | +0·518 |
| 90 | +0·255 | +0·304 |
| 105 | +0·284 | +0·051 |
| 120 | +0·173 | -0·105 |
| 135 | +0·041 | -0·124 |
| 150 | -0·035 | -0·063 |
| 165 | -0·056 | +0·002 |
| 180 | -0·056 | +0·028 |

V, A = 1·75, B = 2·75

| V | R | I |
|---|---|---|
| 0 | -1·482 | -0·068 |
| 15 | -1·461 | +0·045 |
| 30 | -1·350 | +0·355 |
| 45 | -1·042 | +0·749 |
| 60 | -0·499 | +1·009 |
| 75 | +0·123 | +0·926 |
| 90 | +0·527 | +0·503 |
| 105 | +0·538 | +0·013 |
| 120 | +0·282 | -0·255 |
| 135 | +0·024 | -0·244 |
| 150 | +0·092 | -0·099 |
| 165 | -0·098 | +0·030 |
| 180 | -0·085 | +0·077 |

V, A = 1·75, B = 3·25

| V | R | I |
|---|---|---|
| 0 | -1·625 | -0·212 |
| 15 | -1·633 | -0·073 |
| 30 | -1·579 | +0·330 |
| 45 | -1·274 | +0·889 |
| 60 | -0·591 | +1·305 |
| 75 | +0·270 | +1·214 |
| 90 | +0·817 | +0·586 |
| 105 | +0·749 | -0·128 |
| 120 | +0·303 | -0·449 |
| 135 | -0·065 | -0·346 |
| 150 | -0·168 | -0·096 |
| 165 | -0·116 | +0·083 |
| 180 | -0·076 | +0·140 |

V, A = 1·75, B = 3·75

| V | R | I |
|---|---|---|
| 0 | -1·368 | -0·374 |
| 15 | -1·423 | -0·242 |
| 30 | -1·495 | +0·178 |
| 45 | -1·309 | +0·847 |
| 60 | -0·603 | +1·429 |
| 75 | +0·438 | +1·369 |
| 90 | +1·090 | +0·550 |
| 105 | +0·882 | -0·358 |
| 120 | +0·218 | -0·655 |
| 135 | -0·218 | -0·395 |
| 150 | -0·244 | -0·043 |
| 165 | -0·098 | +0·148 |
| 180 | -0·022 | +0·197 |

V, A = 1·75, B = 4·25

| V | R | I |
|---|---|---|
| 0 | -0·799 | -0·490 |
| 15 | -0·906 | -0·403 |
| 30 | -1·137 | -0·061 |
| 45 | -1·172 | +0·630 |
| 60 | -0·568 | +1·369 |
| 75 | +0·582 | +1·391 |
| 90 | +1·305 | +0·413 |
| 105 | +0·909 | -0·641 |
| 120 | +0·026 | -0·825 |
| 135 | -0·407 | -0·363 |
| 150 | -0·293 | +0·057 |
| 165 | -0·039 | +0·205 |
| 180 | +0·069 | +0·221 |

V, A = 1·75, B = 4·75

| V | R | I |
|---|---|---|
| 0 | -0·068 | -0·509 |
| 15 | -0·209 | -0·499 |
| 30 | -0·589 | -0·330 |
| 45 | -0·906 | +0·271 |
| 60 | -0·527 | +1·140 |
| 75 | +0·658 | +1·300 |
| 90 | +1·430 | +0·211 |
| 105 | +0·818 | -0·931 |
| 120 | -0·253 | -0·913 |
| 135 | -0·591 | -0·231 |
| 150 | -0·291 | +0·189 |
| 165 | +0·052 | +0·231 |
| 180 | +0·176 | +0·194 |

V, A = 1·75, B = 5·25

| V | R | I |
|---|---|---|
| 0 | +0·648 | -0·407 |
| 15 | +0·504 | -0·491 |
| 30 | +0·038 | -0·565 |
| 45 | -0·564 | -0·170 |
| 60 | -0·510 | +0·778 |
| 75 | +0·637 | +1·133 |
| 90 | +1·450 | +0·012 |
| 105 | +0·617 | -1·179 |
| 120 | -0·578 | -0·882 |
| 135 | -0·718 | -0·006 |
| 150 | -0·221 | +0·325 |
| 165 | +0·158 | +0·209 |
| 180 | +0·267 | +0·110 |

V, A = 1·75, B = 5·75

| V | R | I |
|---|---|---|
| 0 | +1·181 | -0·195 |
| 15 | +1·076 | -0·366 |
| 30 | +0·624 | -0·707 |
| 45 | +0·204 | -0·615 |
| 60 | -0·537 | +0·339 |
| 75 | +0·509 | +0·937 |
| 90 | +1·371 | -0·209 |
| 105 | +0·334 | -1·344 |
| 120 | -0·894 | -0·717 |
| 135 | -0·745 | +0·284 |
| 150 | -0·083 | +0·430 |
| 165 | +0·251 | +0·134 |
| 180 | +0·312 | -0·020 |

CYLINDER RADIUS 2.0 RADIANS (0.32λ)

VERTICAL DIPOLE

V, A = 2.0, B = 2.5

| A | R | I |
|---|---|---|
| 0 | -0.894 | -0.236 |
| 15 | -0.890 | -0.161 |
| 30 | -0.843 | +0.045 |
| 45 | -0.682 | +0.314 |
| 60 | -0.375 | +0.511 |
| 75 | +0.010 | +0.507 |
| 90 | +0.240 | +0.296 |
| 105 | +0.270 | +0.031 |
| 120 | +0.144 | -0.120 |
| 135 | +0.010 | -0.121 |
| 150 | -0.046 | -0.047 |
| 165 | -0.042 | +0.019 |
| 180 | -0.032 | +0.042 |

V, A = 2.0, B = 3.0

| A | R | I |
|---|---|---|
| 0 | -1.425 | -0.451 |
| 15 | -1.436 | -0.325 |
| 30 | -1.402 | +0.038 |
| 45 | -1.167 | +0.535 |
| 60 | -0.634 | +0.922 |
| 75 | -0.045 | +0.919 |
| 90 | +0.503 | +0.499 |
| 105 | +0.512 | -0.015 |
| 120 | +0.227 | -0.272 |
| 135 | -0.028 | -0.228 |
| 150 | -0.104 | -0.068 |
| 165 | -0.067 | +0.052 |
| 180 | -0.038 | +0.091 |

V, A = 2.0, B = 3.5

| A | R | I |
|---|---|---|
| 0 | -1.538 | -0.622 |
| 15 | -1.585 | -0.476 |
| 30 | -1.630 | -0.032 |
| 45 | -1.429 | +0.637 |
| 60 | -0.771 | +1.210 |
| 75 | +0.166 | +1.225 |
| 90 | +0.789 | +0.593 |
| 105 | +0.712 | -0.156 |
| 120 | +0.228 | -0.456 |
| 135 | -0.127 | -0.306 |
| 150 | -0.171 | -0.050 |
| 165 | -0.068 | +0.099 |
| 180 | -0.010 | +0.138 |

V, A = 2.0, B = 4.0

| A | R | I |
|---|---|---|
| 0 | -1.256 | -0.705 |
| 15 | -1.347 | -0.580 |
| 30 | -1.521 | -0.152 |
| 45 | -1.461 | +0.600 |
| 60 | -0.802 | +1.342 |
| 75 | +0.322 | +1.403 |
| 90 | +1.065 | +0.570 |
| 105 | +0.839 | -0.382 |
| 120 | +0.129 | -0.642 |
| 135 | -0.276 | -0.327 |
| 150 | -0.230 | +0.012 |
| 165 | -0.037 | +0.146 |
| 180 | +0.051 | +0.165 |

V, A = 2.0, B = 4.5

| A | R | I |
|---|---|---|
| 0 | -0.675 | -0.665 |
| 15 | -0.805 | -0.601 |
| 30 | -1.120 | -0.297 |
| 45 | -1.288 | +0.421 |
| 60 | -0.758 | +0.299 |
| 75 | +0.469 | +1.446 |
| 90 | +1.291 | +0.444 |
| 105 | +0.863 | -0.659 |
| 120 | -0.067 | -0.785 |
| 135 | -0.447 | -0.265 |
| 150 | -0.256 | +0.112 |
| 165 | +0.024 | +0.177 |
| 180 | +0.132 | +0.156 |

V, A = 2.0, B = 5.0

| A | R | I |
|---|---|---|
| 0 | +0.045 | -0.493 |
| 15 | -0.100 | -0.518 |
| 30 | -0.521 | -0.433 |
| 45 | -0.956 | +0.125 |
| 60 | -0.680 | +1.086 |
| 75 | +0.563 | +1.368 |
| 90 | +1.431 | +0.246 |
| 105 | +0.772 | -0.944 |
| 120 | -0.339 | -0.844 |
| 135 | -0.597 | -0.113 |
| 150 | -0.230 | +0.233 |
| 165 | +0.104 | +0.176 |
| 180 | +0.210 | +0.101 |

V, A = 2.0, B = 5.5

| A | R | I |
|---|---|---|
| 0 | +0.723 | -0.212 |
| 15 | +0.602 | -0.334 |
| 30 | +0.152 | -0.522 |
| 45 | -0.533 | -0.243 |
| 60 | -0.607 | +0.734 |
| 75 | +0.567 | +1.201 |
| 90 | +1.468 | +0.019 |
| 105 | +0.572 | -1.189 |
| 120 | -0.646 | -0.787 |
| 135 | -0.680 | +0.119 |
| 150 | -0.140 | +0.346 |
| 165 | +0.185 | +0.133 |
| 180 | +0.258 | +0.003 |

V, A = 2.0, B = 6.0

| A | R | I |
|---|---|---|
| 0 | +1.198 | +0.124 |
| 15 | +1.138 | -0.077 |
| 30 | +0.766 | -0.534 |
| 45 | -0.088 | -0.618 |
| 60 | -0.566 | +0.294 |
| 75 | +0.464 | +0.991 |
| 90 | +1.402 | -0.189 |
| 105 | +0.287 | -1.353 |
| 120 | -0.935 | -0.603 |
| 135 | -0.659 | +0.397 |
| 150 | +0.007 | +0.418 |
| 165 | +0.244 | +0.049 |
| 180 | +0.255 | -0.118 |

14

VERTICAL DIPOLE

CYLINDER RADIUS 2·5 RADIANS (0·40λ)

V A = 2·5   B = 3·0

| | R | I |
|---|---|---|
| 0 | −0·656 | −0·653 |
| 15 | −0·598 | −0·574 |
| 30 | −0·772 | −0·332 |
| 45 | −0·740 | −0·036 |
| 60 | −0·489 | +0·373 |
| 75 | −0·085 | +0·478 |
| 90 | +0·220 | +0·282 |
| 105 | +0·247 | −0·002 |
| 120 | +0·090 | −0·135 |
| 135 | −0·039 | −0·096 |
| 150 | −0·054 | −0·014 |
| 165 | +0·013 | +0·029 |
| 180 | +0·010 | +0·038 |

V A = 2·5   B = 3·5

| | R | I |
|---|---|---|
| 0 | −1·028 | −1·111 |
| 15 | −1·116 | −0·987 |
| 30 | −1·286 | −0·587 |
| 45 | −1·283 | +0·063 |
| 60 | −0·854 | +0·702 |
| 75 | +0·099 | +0·889 |
| 90 | +0·466 | +0·488 |
| 105 | +0·468 | −0·065 |
| 120 | −0·128 | −0·283 |
| 135 | −0·108 | −0·168 |
| 150 | −0·108 | −0·005 |
| 165 | −0·012 | +0·059 |
| 180 | +0·035 | +0·066 |

V A = 2·5   B = 4·0

| | R | I |
|---|---|---|
| 0 | −1·064 | −1·318 |
| 15 | −1·196 | −1·192 |
| 30 | −1·482 | −0·747 |
| 45 | −1·582 | +0·069 |
| 60 | −1·076 | +0·950 |
| 75 | −0·035 | +1·216 |
| 90 | +0·742 | +0·597 |
| 105 | +0·649 | −0·211 |
| 120 | +0·094 | −0·444 |
| 135 | −0·214 | −0·198 |
| 150 | −0·153 | +0·035 |
| 165 | +0·007 | +0·086 |
| 180 | +0·075 | +0·075 |

V A = 2·5   B = 4·5

| | R | I |
|---|---|---|
| 0 | −0·793 | −1·245 |
| 15 | −0·953 | −1·163 |
| 30 | −1·349 | −0·800 |
| 45 | −1·615 | +0·034 |
| 60 | −1·153 | +1·085 |
| 75 | +0·088 | +1·431 |
| 90 | +1·020 | +0·596 |
| 105 | +0·760 | −0·432 |
| 120 | −0·024 | −0·590 |
| 135 | −0·341 | −0·167 |
| 150 | −0·176 | +0·106 |
| 165 | +0·044 | +0·102 |
| 180 | +0·122 | +0·058 |

V A = 2·5   B = 5·0

| | R | I |
|---|---|---|
| 0 | −0·312 | −0·914 |
| 15 | −0·472 | −0·913 |
| 30 | −0·932 | −0·746 |
| 45 | −1·398 | −0·054 |
| 60 | −1·104 | +1·076 |
| 75 | +0·231 | +1·516 |
| 90 | +1·259 | +0·490 |
| 105 | +0·773 | −0·701 |
| 120 | −0·222 | −0·684 |
| 135 | −0·461 | −0·064 |
| 150 | −0·158 | +0·196 |
| 165 | +0·093 | +0·096 |
| 180 | +0·161 | +0·011 |

V A = 2·5   B = 5·5

| | R | I |
|---|---|---|
| 0 | +0·239 | −0·398 |
| 15 | +0·116 | −0·492 |
| 30 | −0·329 | −0·597 |
| 45 | −0·981 | −0·197 |
| 60 | −0·970 | +0·911 |
| 75 | +0·348 | +1·471 |
| 90 | +1·423 | +0·303 |
| 105 | +0·675 | −0·976 |
| 120 | −0·474 | −0·593 |
| 135 | −0·538 | +0·108 |
| 150 | −0·091 | +0·283 |
| 165 | +0·141 | +0·064 |
| 180 | +0·176 | −0·061 |

V A = 2·5   B = 6·0

| | R | I |
|---|---|---|
| 0 | +0·711 | +0·189 |
| 15 | +0·663 | +0·012 |
| 30 | +0·331 | −0·380 |
| 45 | −0·443 | −0·373 |
| 60 | −0·795 | +0·604 |
| 75 | +0·395 | +1·317 |
| 90 | +1·487 | +0·075 |
| 105 | +0·470 | −1·212 |
| 120 | −0·743 | −0·593 |
| 135 | −0·537 | +0·327 |
| 150 | +0·025 | +0·341 |
| 165 | +0·175 | +0·004 |
| 180 | +0·152 | −0·143 |

V A = 2·5   B = 6·5

| | R | I |
|---|---|---|
| 0 | +0·984 | +0·720 |
| 15 | +1·036 | +0·497 |
| 30 | +0·911 | −0·125 |
| 45 | +0·123 | −0·567 |
| 60 | −0·624 | +0·195 |
| 75 | +0·347 | +1·096 |
| 90 | +1·444 | −0·148 |
| 105 | +0·180 | −1·368 |
| 120 | −0·980 | −0·379 |
| 135 | −0·434 | +0·555 |
| 150 | +0·174 | +0·344 |
| 165 | +0·179 | −0·073 |
| 180 | +0·086 | −0·213 |

# VERTICAL DIPOLE

# CYLINDER RADIUS 3.0 RADIANS (0.48λ)

## V A = 3.0  B = 3.5

| | R | I |
|---|---|---|
| 0 | -0.246 | -0.894 |
| 15 | -0.336 | -0.839 |
| 30 | -0.546 | -0.635 |
| 45 | -0.695 | -0.236 |
| 60 | -0.562 | -0.227 |
| 75 | -0.150 | -0.443 |
| 90 | +0.205 | +0.269 |
| 105 | +0.226 | -0.031 |
| 120 | +0.044 | -0.136 |
| 135 | -0.066 | -0.059 |
| 150 | -0.047 | +0.016 |
| 165 | +0.006 | +0.022 |
| 180 | +0.028 | +0.012 |

## V A = 3.0  B = 4.0

| | R | I |
|---|---|---|
| 0 | -0.354 | -1.488 |
| 15 | -0.515 | -1.412 |
| 30 | -0.908 | -1.095 |
| 45 | -1.217 | -0.411 |
| 60 | -1.003 | +0.439 |
| 75 | -0.230 | +0.841 |
| 90 | +0.436 | +0.475 |
| 105 | +0.427 | -0.114 |
| 120 | +0.045 | -0.275 |
| 135 | -0.146 | -0.091 |
| 150 | -0.083 | +0.047 |
| 165 | +0.020 | +0.040 |
| 180 | +0.057 | +0.012 |

## V A = 3.0  B = 4.5

| | R | I |
|---|---|---|
| 0 | -0.298 | -1.696 |
| 15 | -0.502 | -1.640 |
| 30 | -1.031 | -1.330 |
| 45 | -1.512 | -0.514 |
| 60 | -1.294 | +0.623 |
| 75 | -0.224 | +1.177 |
| 90 | +0.701 | +0.594 |
| 105 | +0.586 | -0.267 |
| 120 | -0.016 | -0.411 |
| 135 | -0.241 | -0.080 |
| 150 | -0.101 | +0.099 |
| 165 | +0.043 | +0.049 |
| 180 | +0.084 | -0.005 |

## V A = 3.0  B = 5.0

| | R | I |
|---|---|---|
| 0 | -0.111 | -1.502 |
| 15 | -0.316 | -1.502 |
| 30 | -0.903 | -1.321 |
| 45 | -1.547 | -0.555 |
| 60 | -1.416 | +0.742 |
| 75 | -0.142 | +1.420 |
| 90 | +0.975 | +0.611 |
| 105 | +0.678 | -0.486 |
| 120 | -0.149 | -0.520 |
| 135 | -0.334 | -0.015 |
| 150 | -0.088 | +0.163 |
| 165 | +0.072 | +0.043 |
| 180 | +0.100 | -0.041 |

## V A = 3.0  B = 5.5

| | R | I |
|---|---|---|
| 0 | +0.140 | -0.972 |
| 15 | -0.020 | -1.048 |
| 30 | -0.560 | -1.087 |
| 45 | -1.324 | -0.552 |
| 60 | -1.378 | +0.760 |
| 75 | +0.015 | +1.543 |
| 90 | +0.222 | +0.525 |
| 105 | +0.675 | -0.746 |
| 120 | -0.343 | -0.571 |
| 135 | -0.399 | +0.106 |
| 150 | -0.037 | +0.226 |
| 165 | +0.101 | +0.020 |
| 180 | +0.096 | -0.088 |

## V A = 3.0  B = 6.0

| | R | I |
|---|---|---|
| 0 | +0.369 | -0.240 |
| 15 | +0.299 | -0.387 |
| 30 | -0.081 | -0.685 |
| 45 | -0.889 | -0.525 |
| 60 | -1.207 | +0.654 |
| 75 | +0.114 | +1.535 |
| 90 | +0.403 | +0.353 |
| 105 | +0.564 | -1.007 |
| 120 | -0.574 | -0.536 |
| 135 | -0.409 | +0.270 |
| 150 | +0.053 | +0.267 |
| 165 | +0.119 | -0.020 |
| 180 | +0.065 | -0.137 |

## V A = 3.0  B = 6.5

| | R | I |
|---|---|---|
| 0 | +0.503 | +0.518 |
| 15 | +0.551 | +0.329 |
| 30 | +0.428 | -0.194 |
| 45 | +0.318 | -0.491 |
| 60 | -0.953 | +0.419 |
| 75 | +0.199 | +0.405 |
| 90 | +1.491 | +0.131 |
| 105 | +0.350 | -1.227 |
| 120 | -0.804 | -0.399 |
| 135 | -0.342 | +0.450 |
| 150 | +0.170 | +0.265 |
| 165 | +0.117 | -0.072 |
| 180 | +0.007 | -0.172 |

## V A = 3.0  B = 7.0

| | R | I |
|---|---|---|
| 0 | +0.497 | +1.123 |
| 15 | +0.665 | +0.945 |
| 30 | +0.857 | +0.294 |
| 45 | +0.290 | -0.458 |
| 60 | -0.669 | +0.077 |
| 75 | +0.203 | +1.186 |
| 90 | +1.473 | -0.099 |
| 105 | +0.056 | -1.365 |
| 120 | -0.988 | -0.161 |
| 135 | -0.189 | +0.610 |
| 150 | +0.291 | +0.205 |
| 165 | +0.089 | -0.125 |
| 180 | -0.070 | -0.177 |

VERTICAL DIPOLE    CYLINDER RADIUS 3.5 RADIANS (0.56λ)

**A = 3.5   B = 4.0**

| V/A | R | I |
|---|---|---|
| 0 | +0.226 | -0.900 |
| 15 | +0.106 | -0.898 |
| 30 | -0.215 | -0.807 |
| 45 | -0.557 | -0.469 |
| 60 | -0.592 | -0.068 |
| 75 | -0.208 | -0.404 |
| 90 | +0.192 | -0.258 |
| 105 | +0.205 | -0.058 |
| 120 | +0.005 | -0.130 |
| 135 | -0.073 | -0.021 |
| 150 | -0.026 | -0.035 |
| 165 | +0.014 | +0.011 |
| 180 | +0.021 | -0.011 |

**A = 3.5   B = 4.5**

| V/A | R | I |
|---|---|---|
| 0 | +0.422 | -1.484 |
| 15 | +0.219 | -1.499 |
| 30 | -0.347 | -1.387 |
| 45 | -0.986 | -0.824 |
| 60 | -1.075 | +0.154 |
| 75 | -0.346 | +0.780 |
| 90 | +0.410 | +0.463 |
| 105 | +0.383 | +0.158 |
| 120 | -0.026 | -0.254 |
| 135 | -0.148 | -0.019 |
| 150 | -0.038 | +0.077 |
| 165 | +0.031 | +0.016 |
| 180 | +0.037 | -0.028 |

**A = 3.5   B = 5.0**

| V/A | R | I |
|---|---|---|
| 0 | +0.566 | -1.651 |
| 15 | +0.331 | -1.705 |
| 30 | -0.366 | -1.662 |
| 45 | -1.234 | -1.032 |
| 60 | -1.412 | +0.254 |
| 75 | -0.396 | +1.114 |
| 90 | +0.664 | +0.591 |
| 105 | +0.520 | -0.318 |
| 120 | -0.111 | -0.363 |
| 135 | -0.221 | +0.021 |
| 150 | -0.028 | +0.124 |
| 165 | +0.049 | +0.011 |
| 180 | +0.042 | -0.053 |

**A = 3.5   B = 5.5**

| V/A | R | I |
|---|---|---|
| 0 | +0.626 | -1.397 |
| 15 | +0.420 | -1.503 |
| 30 | -0.265 | -1.605 |
| 45 | -1.264 | -1.086 |
| 60 | -1.574 | +0.340 |
| 75 | -0.359 | +1.375 |
| 90 | +0.933 | +0.624 |
| 105 | +0.589 | -0.533 |
| 120 | -0.252 | -0.435 |
| 135 | -0.276 | +0.102 |
| 150 | +0.011 | +0.167 |
| 165 | +0.066 | -0.005 |
| 180 | +0.031 | -0.082 |

**A = 3.5   B = 6.0**

| V/A | R | I |
|---|---|---|
| 0 | +0.578 | -0.811 |
| 15 | +0.458 | -0.962 |
| 30 | -0.065 | -1.247 |
| 45 | -1.071 | -1.001 |
| 60 | -1.553 | +0.377 |
| 75 | -0.255 | +1.529 |
| 90 | +1.185 | +0.556 |
| 105 | +0.568 | -0.780 |
| 120 | -0.438 | -0.445 |
| 135 | -0.292 | +0.220 |
| 150 | +0.079 | +0.192 |
| 165 | +0.075 | -0.032 |
| 180 | +0.002 | -0.107 |

**A = 3.5   B = 6.5**

| V/A | R | I |
|---|---|---|
| 0 | +0.417 | -0.051 |
| 15 | +0.423 | -0.221 |
| 30 | +0.189 | -0.672 |
| 45 | -0.682 | -0.814 |
| 60 | -1.369 | -0.331 |
| 75 | -0.125 | +1.556 |
| 90 | +1.381 | +0.400 |
| 105 | +0.445 | -1.024 |
| 120 | -0.644 | -0.369 |
| 135 | -0.252 | +0.358 |
| 150 | +0.166 | +0.184 |
| 165 | +0.071 | -0.066 |
| 180 | -0.043 | -0.118 |

**A = 3.5   B = 7.0**

| V/A | R | I |
|---|---|---|
| 0 | +0.165 | +0.692 |
| 15 | +0.307 | +0.544 |
| 30 | +0.441 | -0.000 |
| 45 | -0.162 | -0.571 |
| 60 | -1.064 | +0.183 |
| 75 | -0.013 | +1.456 |
| 90 | +1.490 | +0.185 |
| 105 | +0.225 | -1.223 |
| 120 | -0.831 | -0.200 |
| 135 | -0.143 | +0.488 |
| 150 | +0.256 | +0.132 |
| 165 | +0.049 | -0.100 |
| 180 | -0.097 | -0.106 |

**A = 3.5   B = 7.5**

| V/A | R | I |
|---|---|---|
| 0 | -0.130 | +1.238 |
| 15 | +0.124 | +1.156 |
| 30 | +0.627 | +0.638 |
| 45 | +0.401 | -0.314 |
| 60 | -0.694 | -0.062 |
| 75 | +0.039 | +1.249 |
| 90 | +1.498 | -0.048 |
| 105 | -0.070 | -1.341 |
| 120 | -0.958 | +0.056 |
| 135 | +0.032 | +0.577 |
| 150 | +0.325 | +0.032 |
| 165 | +0.008 | -0.126 |
| 180 | -0.145 | -0.066 |

## VERTICAL DIPOLE  CYLINDER RADIUS 4.0 RADIANS (0.64λ)

### V, A = 4.0, B = 4.5

| | R | I |
|---|---|---|
| 0 | +0.639 | -0.675 |
| 15 | +0.521 | -0.740 |
| 30 | +0.154 | -0.820 |
| 45 | -0.349 | -0.635 |
| 60 | -0.581 | -0.089 |
| 75 | -0.257 | +0.361 |
| 90 | +0.182 | +0.250 |
| 105 | +0.182 | -0.080 |
| 120 | -0.030 | -0.116 |
| 135 | -0.066 | +0.009 |
| 150 | -0.001 | +0.039 |
| 165 | +0.014 | +0.000 |
| 180 | +0.004 | -0.019 |

### V, A = 4.0, B = 5.0

| | R | I |
|---|---|---|
| 0 | +1.098 | -1.098 |
| 15 | +0.907 | -1.226 |
| 30 | +0.284 | -1.407 |
| 45 | -0.623 | -1.123 |
| 60 | -1.069 | -0.135 |
| 75 | -0.448 | +0.707 |
| 90 | +0.389 | +0.452 |
| 105 | +0.339 | -0.193 |
| 120 | -0.087 | -0.220 |
| 135 | -0.126 | +0.037 |
| 150 | +0.011 | +0.075 |
| 165 | +0.028 | -0.004 |
| 180 | +0.002 | -0.038 |

### V, A = 4.0, B = 5.5

| | R | I |
|---|---|---|
| 0 | +1.306 | -1.186 |
| 15 | +1.103 | -1.366 |
| 30 | +0.382 | -1.674 |
| 45 | -0.786 | -1.414 |
| 60 | -1.427 | -0.129 |
| 75 | -0.551 | +1.029 |
| 90 | +0.633 | +0.587 |
| 105 | +0.453 | -0.358 |
| 120 | -0.188 | -0.299 |
| 135 | -0.173 | +0.093 |
| 150 | +0.041 | +0.105 |
| 165 | +0.038 | -0.015 |
| 180 | -0.010 | -0.055 |

### V, A = 4.0, B = 6.0

| | R | I |
|---|---|---|
| 0 | +1.232 | -0.944 |
| 15 | +1.082 | -1.155 |
| 30 | +0.443 | -1.589 |
| 45 | -0.805 | -1.482 |
| 60 | -1.617 | -0.089 |
| 75 | -0.560 | +1.296 |
| 90 | +0.898 | +0.632 |
| 105 | +0.501 | -0.568 |
| 120 | -0.332 | -0.334 |
| 135 | -0.193 | +0.178 |
| 150 | +0.090 | +0.120 |
| 165 | +0.043 | -0.034 |
| 180 | -0.033 | -0.065 |

### V, A = 4.0, B = 6.5

| | R | I |
|---|---|---|
| 0 | +0.898 | -0.458 |
| 15 | +0.854 | -0.663 |
| 30 | +0.464 | -1.184 |
| 45 | -0.665 | -1.337 |
| 60 | -1.619 | -0.045 |
| 75 | -0.487 | +1.474 |
| 90 | +1.152 | +0.580 |
| 105 | +0.462 | -0.803 |
| 120 | -0.503 | -0.304 |
| 135 | -0.171 | +0.281 |
| 150 | +0.152 | +0.108 |
| 165 | +0.038 | -0.056 |
| 180 | -0.064 | -0.062 |

### V, A = 4.0, B = 7.0

| | R | I |
|---|---|---|
| 0 | +0.380 | +0.133 |
| 15 | +0.467 | -0.021 |
| 30 | +0.442 | -0.553 |
| 45 | -0.377 | -1.022 |
| 60 | -1.440 | -0.034 |
| 75 | -0.364 | +1.535 |
| 90 | +1.359 | +0.439 |
| 105 | +0.327 | -1.028 |
| 120 | -0.675 | -0.193 |
| 135 | -0.095 | +0.384 |
| 150 | +0.214 | +0.063 |
| 165 | +0.020 | -0.079 |
| 180 | -0.096 | -0.043 |

### V, A = 4.0, B = 7.5

| | R | I |
|---|---|---|
| 0 | -0.206 | +0.672 |
| 15 | -0.000 | +0.610 |
| 30 | +0.379 | +0.171 |
| 45 | +0.018 | -0.603 |
| 60 | -1.113 | -0.085 |
| 75 | -0.234 | +1.467 |
| 90 | +1.487 | +0.232 |
| 105 | +0.102 | -1.207 |
| 120 | -0.813 | -0.000 |
| 135 | +0.035 | +0.461 |
| 150 | +0.259 | +0.016 |
| 165 | -0.010 | -0.094 |
| 180 | -0.120 | -0.005 |

### V, A = 4.0, B = 8.0

| | R | I |
|---|---|---|
| 0 | -0.732 | +1.021 |
| 15 | -0.451 | +1.078 |
| 30 | +0.276 | +0.840 |
| 45 | +0.454 | -0.152 |
| 60 | -0.691 | -0.215 |
| 75 | -0.142 | +1.282 |
| 90 | +1.515 | -0.002 |
| 105 | -0.192 | -1.303 |
| 120 | -0.880 | +0.262 |
| 135 | +0.210 | +0.485 |
| 150 | +0.269 | -0.123 |
| 165 | -0.050 | -0.095 |
| 180 | -0.127 | +0.046 |

VERTICAL DIPOLE

CYLINDER RADIUS 4.5 RADIANS (0.72λ)

| V<br>A = 4.5, B = 5.0 | R | I |
|---|---|---|
| 0 | +0.888 | -0.278 |
| 15 | +0.810 | -0.406 |
| 30 | +0.491 | -0.673 |
| 45 | -0.098 | -0.714 |
| 60 | -0.531 | -0.235 |
| 75 | -0.299 | +0.314 |
| 90 | +0.174 | +0.242 |
| 105 | +0.161 | -0.097 |
| 120 | -0.057 | -0.095 |
| 135 | -0.051 | +0.032 |
| 150 | +0.019 | +0.028 |
| 165 | +0.019 | -0.007 |
| 180 | -0.010 | -0.013 |

| V<br>A = 4.5, B = 5.5 | R | I |
|---|---|---|
| 0 | +1.502 | -0.430 |
| 15 | +1.385 | -0.657 |
| 30 | +0.862 | -1.154 |
| 45 | -0.180 | -1.272 |
| 60 | -0.990 | -0.407 |
| 75 | -0.536 | +0.623 |
| 90 | +0.372 | +0.442 |
| 105 | +0.295 | -0.223 |
| 120 | -0.134 | -0.173 |
| 135 | -0.091 | +0.076 |
| 150 | +0.045 | +0.049 |
| 165 | +0.017 | -0.017 |
| 180 | -0.023 | -0.022 |

| V<br>A = 4.5, B = 6.0 | R | I |
|---|---|---|
| 0 | +1.732 | -0.414 |
| 15 | +1.629 | -0.698 |
| 30 | +1.067 | -1.363 |
| 45 | -0.231 | -1.609 |
| 60 | -1.341 | -0.499 |
| 75 | -0.689 | +0.925 |
| 90 | +0.607 | +0.581 |
| 105 | +0.387 | -0.391 |
| 120 | -0.244 | -0.221 |
| 135 | -0.111 | +0.138 |
| 150 | +0.081 | +0.057 |
| 165 | +0.020 | -0.030 |
| 180 | -0.040 | -0.024 |

| V<br>A = 4.5, B = 6.5 | R | I |
|---|---|---|
| 0 | +1.551 | -0.247 |
| 15 | +1.512 | -0.530 |
| 30 | +1.085 | -1.268 |
| 45 | -0.229 | -1.687 |
| 60 | -1.543 | -0.513 |
| 75 | -0.743 | +1.190 |
| 90 | +0.866 | +0.637 |
| 105 | +0.414 | -0.596 |
| 120 | -0.381 | -0.222 |
| 135 | -0.101 | +0.216 |
| 150 | +0.124 | +0.045 |
| 165 | +0.015 | -0.045 |
| 180 | -0.059 | -0.016 |

| V<br>A = 4.5, B = 7.0 | R | I |
|---|---|---|
| 0 | +1.019 | +0.012 |
| 15 | +1.075 | -0.208 |
| 30 | +0.927 | -0.900 |
| 45 | -0.157 | -1.509 |
| 60 | -1.568 | -0.471 |
| 75 | -0.704 | +1.384 |
| 90 | +1.120 | +0.599 |
| 105 | +0.358 | -0.817 |
| 120 | -0.529 | -0.157 |
| 135 | -0.050 | +0.296 |
| 150 | +0.165 | +0.009 |
| 165 | +0.001 | -0.059 |
| 180 | -0.075 | -0.004 |

| V<br>A = 4.5, B = 7.5 | R | I |
|---|---|---|
| 0 | +0.271 | +0.279 |
| 15 | +0.424 | +0.177 |
| 30 | +0.632 | -0.339 |
| 45 | -0.007 | -1.114 |
| 60 | -1.410 | -0.410 |
| 75 | -0.597 | +1.474 |
| 90 | +1.335 | +0.471 |
| 105 | +0.212 | -1.024 |
| 120 | -0.662 | -0.020 |
| 135 | +0.046 | +0.360 |
| 150 | +0.192 | -0.052 |
| 165 | -0.022 | -0.067 |
| 180 | -0.082 | +0.034 |

| V<br>A = 4.5, B = 8.0 | R | I |
|---|---|---|
| 0 | -0.512 | +0.472 |
| 15 | -0.292 | +0.520 |
| 30 | +0.260 | +0.294 |
| 45 | +0.207 | -0.579 |
| 60 | -1.089 | -0.368 |
| 75 | -0.458 | +1.441 |
| 90 | +1.478 | +0.273 |
| 105 | -0.018 | -1.181 |
| 120 | -0.748 | +0.185 |
| 135 | +0.181 | +0.386 |
| 150 | +0.191 | -0.132 |
| 165 | -0.051 | +0.065 |
| 180 | -0.075 | +0.070 |

| V<br>A = 4.5, B = 8.5 | R | I |
|---|---|---|
| 0 | -1.149 | +0.532 |
| 15 | -0.918 | +0.732 |
| 30 | -0.122 | +0.866 |
| 45 | +0.453 | +0.005 |
| 60 | -0.650 | -0.373 |
| 75 | -0.333 | +1.285 |
| 90 | +1.525 | +0.041 |
| 105 | +0.311 | -1.256 |
| 120 | -0.757 | -0.439 |
| 135 | +0.339 | +0.354 |
| 150 | +0.152 | +0.218 |
| 165 | -0.082 | -0.048 |
| 180 | -0.050 | +0.104 |

# VERTICAL DIPOLE

## CYLINDER RADIUS 5.0 RADIANS (0.80λ)

### V, A = 5.0, B = 5.5

| A | R | I |
|---|---|---|
| 0 | +0.913 | +0.189 |
| 15 | +0.907 | +0.024 |
| 30 | +0.731 | −0.398 |
| 45 | +0.162 | −0.699 |
| 60 | −0.448 | −0.361 |
| 75 | −0.333 | +0.263 |
| 90 | +0.166 | +0.234 |
| 105 | +0.139 | −0.112 |
| 120 | −0.075 | −0.070 |
| 135 | −0.030 | +0.045 |
| 150 | +0.027 | +0.010 |
| 165 | +0.003 | −0.010 |
| 180 | −0.013 | −0.001 |

### V, A = 5.0, B = 6.0

| A | R | I |
|---|---|---|
| 0 | +1.530 | +0.354 |
| 15 | +1.538 | +0.071 |
| 30 | +1.277 | −0.678 |
| 45 | +0.285 | −1.252 |
| 60 | −0.845 | −0.647 |
| 75 | −0.610 | +0.532 |
| 90 | +0.357 | +0.433 |
| 105 | +0.252 | −0.247 |
| 120 | −0.164 | −0.120 |
| 135 | −0.048 | +0.097 |
| 150 | +0.056 | +0.013 |
| 165 | +0.004 | −0.021 |
| 180 | −0.026 | +0.002 |

### V, A = 5.0, B = 6.5

| A | R | I |
|---|---|---|
| 0 | +1.731 | +0.475 |
| 15 | +1.780 | +0.145 |
| 30 | +1.556 | −0.785 |
| 45 | +0.358 | −1.592 |
| 60 | −1.162 | −0.830 |
| 75 | −0.807 | +0.806 |
| 90 | +0.583 | +0.574 |
| 105 | +0.321 | −0.417 |
| 120 | −0.274 | −0.138 |
| 135 | −0.044 | +0.157 |
| 150 | +0.086 | +0.002 |
| 165 | −0.001 | −0.032 |
| 180 | −0.037 | +0.012 |

### V, A = 5.0, B = 7.0

| A | R | I |
|---|---|---|
| 0 | +1.496 | +0.527 |
| 15 | +1.601 | +0.233 |
| 30 | +1.534 | −0.700 |
| 45 | +0.386 | −1.674 |
| 60 | −1.360 | −0.901 |
| 75 | −0.905 | +1.061 |
| 90 | +0.836 | +0.639 |
| 105 | +0.327 | −0.616 |
| 120 | −0.397 | −0.107 |
| 135 | −0.009 | +0.219 |
| 150 | +0.113 | −0.026 |
| 165 | +0.012 | −0.041 |
| 180 | −0.043 | +0.028 |

### V, A = 5.0, B = 7.5

| A | R | I |
|---|---|---|
| 0 | +0.904 | +0.490 |
| 15 | +1.064 | +0.306 |
| 30 | +1.234 | −0.440 |
| 45 | +0.387 | −1.489 |
| 60 | −1.405 | −0.871 |
| 75 | −0.903 | +1.264 |
| 90 | +1.089 | +0.613 |
| 105 | +0.255 | −0.824 |
| 120 | −0.518 | −0.017 |
| 135 | +0.060 | +0.271 |
| 150 | +0.127 | −0.070 |
| 165 | −0.030 | −0.044 |
| 180 | −0.041 | +0.049 |

### V, A = 5.0, B = 8.0

| A | R | I |
|---|---|---|
| 0 | +0.115 | +0.359 |
| 15 | +0.303 | +0.338 |
| 30 | +0.724 | −0.061 |
| 45 | +0.381 | −1.071 |
| 60 | −1.278 | −0.772 |
| 75 | +0.815 | +1.378 |
| 90 | +0.310 | +0.499 |
| 105 | −0.097 | −1.011 |
| 120 | −0.610 | +0.135 |
| 135 | +0.163 | +0.295 |
| 150 | +0.120 | −0.128 |
| 165 | −0.051 | −0.039 |
| 180 | −0.028 | +0.071 |

### V, A = 5.0, B = 8.5

| A | R | I |
|---|---|---|
| 0 | −0.674 | +0.149 |
| 15 | −0.500 | +0.306 |
| 30 | +0.112 | +0.355 |
| 45 | +0.385 | −0.495 |
| 60 | −0.989 | −0.644 |
| 75 | −0.676 | +1.378 |
| 90 | +1.465 | +0.312 |
| 105 | −0.138 | −1.145 |
| 120 | −0.646 | +0.339 |
| 135 | +0.288 | +0.274 |
| 150 | +0.085 | −0.187 |
| 165 | −0.071 | −0.024 |
| 180 | −0.002 | +0.088 |

### V, A = 5.0, B = 9.0

| A | R | I |
|---|---|---|
| 0 | −1.272 | −0.101 |
| 15 | −1.162 | +0.205 |
| 30 | +0.485 | +0.717 |
| 45 | +0.404 | +0.144 |
| 60 | −0.569 | −0.528 |
| 75 | −0.527 | +1.255 |
| 90 | −1.530 | −0.084 |
| 105 | −0.429 | −1.196 |
| 120 | −0.602 | +0.574 |
| 135 | +0.415 | +0.196 |
| 150 | +0.019 | −0.235 |
| 165 | −0.086 | +0.004 |
| 180 | −0.033 | +0.094 |

VERTICAL DIPOLE

CYLINDER RADIUS 5.5 RADIANS (0·88λ)

**V A = 5.5  B = 6.0**

| A = 5.5 | R | I |
|---|---|---|
| 0 | +0.707 | +0.609 |
| 15 | +0.789 | +0.448 |
| 30 | +0.831 | -0.048 |
| 45 | -0.399 | -0.593 |
| 60 | -0.336 | -0.460 |
| 75 | +0.160 | +0.211 |
| 90 | +0.116 | +0.228 |
| 105 | -0.085 | -0.124 |
| 120 | -0.008 | -0.043 |
| 135 | +0.025 | +0.049 |
| 150 | -0.003 | -0.006 |
| 165 | -0.008 | -0.009 |
| 180 |  | +0.008 |

**V A = 5.5  B = 6.5**

| A = 5.5 | R | I |
|---|---|---|
| 0 | +1.173 | +1.054 |
| 15 | +1.331 | +0.787 |
| 30 | +1.448 | -0.070 |
| 45 | +0.711 | -1.069 |
| 60 | -0.645 | -0.839 |
| 75 | -0.670 | +0.434 |
| 90 | +0.343 | +0.434 |
| 105 | +0.207 | -0.266 |
| 120 | -0.178 | -0.066 |
| 135 | -0.004 | +0.100 |
| 150 | +0.047 | -0.017 |
| 165 | -0.009 | -0.017 |
| 180 | -0.013 | +0.018 |

**V A = 5.5  B = 7.0**

| A = 5.5 | R | I |
|---|---|---|
| 0 | +1.298 | +1.258 |
| 15 | +1.516 | +0.966 |
| 30 | +1.752 | -0.051 |
| 45 | +0.902 | -1.367 |
| 60 | -0.905 | -1.102 |
| 75 | -0.905 | +0.674 |
| 90 | +0.562 | +0.568 |
| 105 | +0.255 | -0.436 |
| 120 | -0.281 | -0.057 |
| 135 | +0.021 | +0.149 |
| 150 | +0.064 | -0.039 |
| 165 | -0.018 | -0.023 |
| 180 | -0.014 | +0.030 |

**V A = 5.5  B = 7.5**

| A = 5.5 | R | I |
|---|---|---|
| 0 | +1.073 | +1.187 |
| 15 | +1.324 | +0.956 |
| 30 | +1.702 | +0.012 |
| 45 | +0.959 | -1.440 |
| 60 | -1.082 | -1.227 |
| 75 | -1.044 | +0.913 |
| 90 | +0.808 | +0.640 |
| 105 | +0.241 | -0.627 |
| 120 | -0.386 | -0.001 |
| 135 | +0.072 | +0.190 |
| 150 | +0.072 | -0.071 |
| 165 | -0.031 | -0.024 |
| 180 | -0.008 | +0.043 |

**V A = 5.5  B = 8.0**

| A = 5.5 | R | I |
|---|---|---|
| 0 | +0.574 | +0.864 |
| 15 | +0.816 | +0.764 |
| 30 | +1.321 | +0.115 |
| 45 | +0.894 | -1.275 |
| 60 | -1.140 | -1.216 |
| 75 | +1.078 | +1.116 |
| 90 | +0.060 | +0.626 |
| 105 | -0.152 | -0.820 |
| 120 | -0.476 | +0.107 |
| 135 | +0.149 | +0.211 |
| 150 | +0.063 | -0.111 |
| 165 | -0.046 | +0.018 |
| 180 | +0.006 | +0.055 |

**V A = 5.5  B = 8.5**

| A = 5.5 | R | I |
|---|---|---|
| 0 | -0.057 | +0.362 |
| 15 | +0.126 | +0.431 |
| 30 | +0.697 | +0.237 |
| 45 | +0.739 | -0.892 |
| 60 | -1.053 | -1.090 |
| 75 | +1.015 | +1.249 |
| 90 | +0.285 | -0.524 |
| 105 | -0.528 | -0.986 |
| 120 | +0.245 | +0.265 |
| 135 | -0.033 | +0.197 |
| 150 | -0.060 | +0.151 |
| 165 | +0.027 | -0.003 |
| 180 |  | +0.060 |

**V A = 5.5  B = 9.0**

| A = 5.5 | R | I |
|---|---|---|
| 0 | -0.654 | -0.207 |
| 15 | -0.576 | +0.024 |
| 30 | -0.041 | +0.352 |
| 45 | +0.534 | -0.353 |
| 60 | +0.816 | -0.891 |
| 75 | -0.882 | +1.280 |
| 90 | +1.451 | +0.348 |
| 105 | -0.255 | -1.096 |
| 120 | +0.519 | +0.460 |
| 135 | +0.345 | +0.137 |
| 150 | -0.019 | -0.181 |
| 165 | -0.067 | +0.020 |
| 180 | +0.053 | -0.055 |

**V A = 5.5  B = 9.5**

| A = 5.5 | R | I |
|---|---|---|
| 0 | -1.067 | -0.716 |
| 15 | -1.124 | -0.376 |
| 30 | -0.742 | +0.428 |
| 45 | +0.320 | +0.254 |
| 60 | -0.447 | -0.667 |
| 75 | -0.716 | +1.192 |
| 90 | +1.532 | +0.125 |
| 105 | -0.541 | -1.122 |
| 120 | -0.430 | +0.667 |
| 135 | +0.429 | +0.028 |
| 150 | -0.089 | -0.189 |
| 165 | -0.064 | +0.048 |
| 180 | +0.078 | +0.037 |

## VERTICAL DIPOLE

## CYLINDER RADIUS 6.0 RADIANS (0.96λ)

V A = 6.0    B = 6.5

|     | R      | I      |
|-----|--------|--------|
| 0   | +0.324 | +0.877 |
| 15  | +0.487 | +0.767 |
| 30  | +0.772 | +0.311 |
| 45  | +0.581 | +0.412 |
| 60  | -0.206 | -0.526 |
| 75  | -0.379 | +0.156 |
| 90  | +0.154 | +0.223 |
| 105 | +0.094 | -0.133 |
| 120 | -0.088 | -0.017 |
| 135 | +0.012 | +0.044 |
| 150 | +0.015 | -0.016 |
| 165 | -0.008 | -0.005 |
| 180 | +0.001 | +0.010 |

V A = 6.0    B = 7.0

|     | R      | I      |
|-----|--------|--------|
| 0   | +0.520 | +1.496 |
| 15  | +0.810 | +1.324 |
| 30  | +1.343 | +0.554 |
| 45  | +1.043 | -0.748 |
| 60  | -0.405 | -0.972 |
| 75  | -0.714 | +0.332 |
| 90  | +0.331 | +0.416 |
| 105 | +0.163 | -0.279 |
| 120 | -0.178 | -0.015 |
| 135 | -0.035 | +0.085 |
| 150 | +0.027 | -0.035 |
| 165 | -0.017 | -0.007 |
| 180 | +0.004 | +0.019 |

V A = 6.0    B = 7.5

|     | R      | I      |
|-----|--------|--------|
| 0   | +0.537 | +1.738 |
| 15  | +0.896 | +1.571 |
| 30  | +1.617 | +0.700 |
| 45  | +1.331 | -0.963 |
| 60  | -0.589 | -1.296 |
| 75  | -0.981 | +0.534 |
| 90  | +0.543 | +0.562 |
| 105 | +0.189 | -0.447 |
| 120 | -0.269 | +0.019 |
| 135 | +0.074 | +0.118 |
| 150 | +0.030 | -0.059 |
| 165 | -0.027 | -0.006 |
| 180 | +0.012 | +0.026 |

V A = 6.0    B = 8.0

|     | R      | I      |
|-----|--------|--------|
| 0   | +0.379 | +1.567 |
| 15  | +0.736 | +1.472 |
| 30  | +1.550 | +0.734 |
| 45  | +1.414 | +1.016 |
| 60  | -0.730 | -1.469 |
| 75  | -1.157 | +0.748 |
| 90  | +0.784 | +0.640 |
| 105 | +0.156 | -0.628 |
| 120 | -0.353 | +0.093 |
| 135 | +0.132 | +0.135 |
| 150 | +0.021 | -0.086 |
| 165 | -0.037 | +0.000 |
| 180 | +0.023 | +0.030 |

V A = 6.0    B = 8.5

|     | R      | I      |
|-----|--------|--------|
| 0   | +0.102 | +1.040 |
| 15  | +0.380 | +1.062 |
| 30  | +1.166 | +0.662 |
| 45  | +1.298 | -0.891 |
| 60  | -0.793 | -1.479 |
| 75  | -1.227 | +0.946 |
| 90  | +1.033 | +0.636 |
| 105 | -0.052 | -0.804 |
| 120 | -0.411 | +0.212 |
| 135 | +0.205 | +0.125 |
| 150 | -0.002 | -0.112 |
| 165 | -0.045 | +0.013 |
| 180 | +0.038 | +0.028 |

V A = 6.0    B = 9.0

|     | R      | I      |
|-----|--------|--------|
| 0   | +0.209 | +0.290 |
| 15  | -0.074 | +0.439 |
| 30  | +0.549 | +0.504 |
| 45  | +1.017 | +0.594 |
| 60  | -0.748 | -1.341 |
| 75  | -1.192 | +1.091 |
| 90  | +1.261 | +0.545 |
| 105 | -0.125 | -0.949 |
| 120 | -0.424 | +0.368 |
| 135 | +0.281 | +0.081 |
| 150 | -0.041 | -0.130 |
| 165 | -0.047 | +0.031 |
| 180 | +0.054 | +0.019 |

V A = 6.0    B = 9.5

|     | R      | I      |
|-----|--------|--------|
| 0   | +0.462 | -0.503 |
| 15  | +0.508 | -0.255 |
| 30  | +0.172 | +0.292 |
| 45  | +0.632 | -0.166 |
| 60  | -0.578 | -1.090 |
| 75  | +1.071 | +1.149 |
| 90  | +1.436 | +0.379 |
| 105 | -0.364 | -0.035 |
| 120 | -0.375 | +0.545 |
| 135 | +0.347 | -0.004 |
| 150 | -0.094 | -0.131 |
| 165 | -0.040 | +0.052 |
| 180 | +0.066 | +0.000 |

V A = 6.0    B = 10.0

|     | R      | I      |
|-----|--------|--------|
| 0   | -0.585 | -1.153 |
| 15  | -0.813 | -0.869 |
| 30  | -0.847 | -0.061 |
| 45  | +0.212 | +0.327 |
| 60  | -0.288 | -0.777 |
| 75  | -0.897 | +1.098 |
| 90  | +1.531 | +0.162 |
| 105 | -0.643 | -1.037 |
| 120 | -0.249 | +0.718 |
| 135 | +0.382 | -0.126 |
| 150 | -0.152 | -0.108 |
| 165 | -0.023 | +0.072 |
| 180 | +0.071 | -0.026 |

## CYLINDER RADIUS 0.25 RADIANS (0.04λ)

## TANGENTIAL DIPOLE

**A = 0.25, B = 0.75**

| TA | R | I |
|---|---|---|
| 0 | +0.593 | +0.596 |
| 15 | +0.578 | +0.546 |
| 30 | +0.528 | +0.415 |
| 45 | +0.440 | +0.246 |
| 60 | +0.312 | +0.090 |
| 75 | +0.157 | -0.013 |
| 90 | -0.014 | -0.044 |
| 105 | -0.184 | +0.004 |
| 120 | -0.340 | +0.124 |
| 135 | -0.467 | +0.293 |
| 150 | -0.556 | +0.472 |
| 165 | -0.605 | +0.610 |
| 180 | -0.621 | +0.662 |

**A = 0.25, B = 1.25**

| TA | R | I |
|---|---|---|
| 0 | +0.221 | +0.900 |
| 15 | +0.246 | +0.841 |
| 30 | +0.298 | +0.676 |
| 45 | +0.325 | +0.444 |
| 60 | +0.280 | +0.207 |
| 75 | +0.155 | +0.034 |
| 90 | -0.022 | -0.027 |
| 105 | -0.199 | +0.044 |
| 120 | -0.325 | +0.227 |
| 135 | -0.369 | +0.472 |
| 150 | -0.342 | +0.710 |
| 165 | -0.290 | +0.879 |
| 180 | -0.265 | +0.940 |

**A = 0.25, B = 1.75**

| TA | R | I |
|---|---|---|
| 0 | -0.264 | +0.970 |
| 15 | -0.198 | +0.930 |
| 30 | -0.033 | +0.802 |
| 45 | +0.137 | +0.580 |
| 60 | +0.212 | +0.308 |
| 75 | +0.144 | +0.078 |
| 90 | -0.026 | -0.012 |
| 105 | -0.196 | +0.078 |
| 120 | -0.264 | +0.308 |
| 135 | -0.189 | +0.581 |
| 150 | -0.019 | +0.803 |
| 165 | +0.146 | +0.932 |
| 180 | +0.213 | +0.971 |

**A = 0.25, B = 2.25**

| TA | R | I |
|---|---|---|
| 0 | -0.702 | +0.796 |
| 15 | -0.612 | +0.801 |
| 30 | -0.369 | +0.775 |
| 45 | -0.073 | +0.641 |
| 60 | +0.130 | +0.386 |
| 75 | +0.135 | +0.119 |
| 90 | -0.025 | +0.000 |
| 105 | -0.185 | +0.109 |
| 120 | -0.181 | +0.368 |
| 135 | +0.022 | +0.615 |
| 150 | +0.319 | +0.743 |
| 165 | +0.561 | +0.766 |
| 180 | +0.652 | +0.759 |

**A = 0.25, B = 2.75**

| TA | R | I |
|---|---|---|
| 0 | -0.978 | +0.425 |
| 15 | -0.894 | +0.486 |
| 30 | -0.641 | +0.601 |
| 45 | -0.273 | +0.618 |
| 60 | +0.044 | +0.437 |
| 75 | +0.128 | +0.154 |
| 90 | -0.020 | +0.011 |
| 105 | -0.168 | +0.137 |
| 120 | -0.084 | +0.404 |
| 135 | +0.233 | +0.571 |
| 150 | +0.601 | +0.544 |
| 165 | +0.854 | +0.422 |
| 180 | +0.938 | +0.359 |

**A = 0.25, B = 3.25**

| TA | R | I |
|---|---|---|
| 0 | -1.021 | -0.051 |
| 15 | -0.977 | +0.058 |
| 30 | -0.798 | +0.314 |
| 45 | -0.440 | +0.515 |
| 60 | +0.042 | +0.455 |
| 75 | +0.122 | +0.182 |
| 90 | -0.012 | +0.017 |
| 105 | -0.146 | +0.161 |
| 120 | +0.018 | +0.414 |
| 135 | +0.416 | +0.457 |
| 150 | +0.774 | +0.244 |
| 165 | +0.953 | -0.021 |
| 180 | +0.997 | -0.133 |

**A = 0.25, B = 3.75**

| TA | R | I |
|---|---|---|
| 0 | -0.819 | -0.513 |
| 15 | -0.841 | -0.382 |
| 30 | -0.810 | -0.033 |
| 45 | -0.553 | +0.343 |
| 60 | -0.125 | +0.438 |
| 75 | +0.116 | +0.200 |
| 90 | -0.002 | +0.019 |
| 105 | -0.120 | +0.179 |
| 120 | +0.121 | +0.398 |
| 135 | +0.548 | +0.286 |
| 150 | +0.806 | +0.102 |
| 165 | +0.836 | -0.460 |
| 180 | +0.814 | -0.593 |

**A = 0.25, B = 4.25**

| TA | R | I |
|---|---|---|
| 0 | -0.419 | -0.847 |
| 15 | -0.516 | -0.734 |
| 30 | -0.676 | -0.375 |
| 45 | -0.601 | +0.125 |
| 60 | -0.203 | +0.388 |
| 75 | +0.106 | +0.209 |
| 90 | +0.007 | +0.017 |
| 105 | -0.093 | +0.193 |
| 120 | +0.216 | +0.356 |
| 135 | +0.614 | +0.080 |
| 150 | +0.689 | -0.430 |
| 165 | +0.528 | -0.795 |
| 180 | +0.431 | -0.910 |

## TANGENTIAL DIPOLE

## CYLINDER RADIUS 0.5 RADIANS (0.08λ)

| T, A = 0.5 | B = 1.0 R | B = 1.0 I | B = 1.5 R | B = 1.5 I | B = 2.0 R | B = 2.0 I | B = 2.5 R | B = 2.5 I |
|---|---|---|---|---|---|---|---|---|
| 0 | +0.168 | +0.616 | -0.245 | +0.900 | -0.697 | +0.930 | -1.022 | +0.718 |
| 15 | +0.179 | +0.563 | -0.192 | +0.848 | -0.611 | +0.909 | -0.927 | +0.749 |
| 30 | +0.197 | +0.419 | -0.066 | +0.695 | -0.388 | +0.821 | -0.660 | +0.784 |
| 45 | +0.195 | +0.230 | +0.058 | +0.462 | -0.129 | +0.629 | -0.305 | +0.707 |
| 60 | +0.150 | +0.049 | +0.105 | +0.205 | +0.038 | +0.352 | +0.022 | +0.467 |
| 75 | +0.062 | -0.073 | +0.048 | +0.004 | +0.037 | +0.090 | +0.044 | +0.169 |
| 90 | -0.052 | -0.107 | -0.081 | -0.071 | -0.092 | -0.026 | -0.085 | +0.016 |
| 105 | -0.166 | -0.043 | -0.210 | -0.008 | -0.221 | +0.060 | -0.214 | +0.110 |
| 120 | -0.252 | +0.108 | -0.265 | +0.212 | -0.219 | +0.293 | -0.147 | +0.352 |
| 135 | -0.295 | +0.313 | -0.215 | +0.472 | -0.050 | +0.546 | +0.138 | +0.545 |
| 150 | -0.295 | +0.521 | -0.088 | +0.707 | +0.211 | +0.720 | +0.495 | +0.584 |
| 165 | -0.275 | +0.676 | +0.040 | +0.861 | +0.436 | +0.795 | +0.763 | +0.526 |
| 180 | -0.263 | +0.734 | +0.093 | +0.914 | +0.523 | +0.812 | +0.858 | +0.488 |

| T, A = 0.5 | B = 3.0 R | B = 3.0 I | B = 3.5 R | B = 3.5 I | B = 4.0 R | B = 4.0 I | B = 4.5 R | B = 4.5 I |
|---|---|---|---|---|---|---|---|---|
| 0 | -1.123 | +0.328 | -0.969 | -0.141 | -0.591 | -0.568 | -0.076 | -0.847 |
| 15 | -1.054 | +0.412 | -0.956 | -0.020 | -0.653 | -0.444 | -0.209 | -0.760 |
| 30 | -0.823 | +0.591 | -0.844 | +0.282 | -0.719 | -0.085 | -0.473 | -0.439 |
| 45 | -0.441 | +0.683 | -0.525 | +0.558 | -0.551 | +0.348 | -0.521 | +0.084 |
| 60 | -0.069 | +0.537 | -0.106 | +0.552 | -0.140 | +0.510 | -0.177 | +0.419 |
| 75 | +0.066 | +0.231 | +0.096 | +0.268 | +0.125 | +0.279 | +0.142 | +0.266 |
| 90 | -0.063 | +0.048 | -0.031 | +0.067 | +0.003 | +0.069 | +0.033 | +0.056 |
| 105 | -0.192 | +0.154 | -0.159 | +0.189 | -0.120 | +0.214 | -0.077 | +0.226 |
| 120 | -0.057 | +0.388 | +0.042 | +0.399 | +0.143 | +0.384 | +0.239 | +0.341 |
| 135 | +0.316 | +0.473 | +0.460 | +0.343 | +0.551 | +0.170 | +0.579 | -0.026 |
| 150 | +0.697 | +0.334 | +0.777 | +0.018 | +0.716 | -0.304 | +0.527 | -0.574 |
| 165 | +0.928 | +0.125 | +0.888 | -0.314 | +0.648 | -0.688 | +0.260 | -0.911 |
| 180 | +0.998 | +0.031 | +0.901 | -0.445 | +0.585 | -0.821 | +0.127 | -1.003 |

TANGENTIAL DIPOLE

CYLINDER RADIUS 0·75 RADIANS (0·12λ)

| T/A | A = 0·75 B = 1·25 R | I |
|---|---|---|
| 0 | -0·225 | +0·641 |
| 15 | -0·190 | +0·592 |
| 30 | -0·109 | +0·452 |
| 45 | -0·032 | +0·255 |
| 60 | -0·003 | +0·052 |
| 75 | -0·035 | -0·098 |
| 90 | -0·106 | -0·153 |
| 105 | -0·174 | -0·096 |
| 120 | -0·198 | +0·055 |
| 135 | -0·158 | +0·259 |
| 150 | -0·069 | +0·457 |
| 165 | +0·020 | +0·597 |
| 180 | +0·057 | +0·647 |

| T/A | A = 0·75 B = 1·75 R | I |
|---|---|---|
| 0 | -0·674 | +0·905 |
| 15 | -0·599 | +0·866 |
| 30 | -0·411 | +0·741 |
| 45 | -0·201 | +0·522 |
| 60 | -0·071 | +0·248 |
| 75 | -0·070 | +0·009 |
| 90 | -0·162 | +0·101 |
| 105 | -0·251 | -0·039 |
| 120 | -0·241 | +0·157 |
| 135 | -0·098 | +0·393 |
| 150 | +0·125 | +0·583 |
| 165 | +0·322 | +0·689 |
| 180 | +0·401 | +0·721 |

| T/A | A = 0·75 B = 2·25 R | I |
|---|---|---|
| 0 | -1·051 | +0·891 |
| 15 | -0·954 | +0·894 |
| 30 | -0·694 | +0·860 |
| 45 | -0·369 | +0·713 |
| 60 | -0·127 | +0·436 |
| 75 | -0·074 | +0·138 |
| 90 | -0·179 | -0·021 |
| 105 | -0·281 | +0·041 |
| 120 | -0·220 | +0·249 |
| 135 | +0·032 | +0·448 |
| 150 | +0·367 | +0·535 |
| 165 | +0·634 | +0·531 |
| 180 | +0·734 | +0·516 |

| T/A | A = 0·75 B = 2·75 R | I |
|---|---|---|
| 0 | -1·223 | +0·639 |
| 15 | -1·135 | +0·696 |
| 30 | -0·873 | +0·799 |
| 45 | -0·489 | +0·793 |
| 60 | -0·150 | +0·579 |
| 75 | -0·040 | +0·253 |
| 90 | -0·158 | +0·056 |
| 105 | -0·275 | +0·123 |
| 120 | -0·162 | +0·328 |
| 135 | +0·181 | +0·438 |
| 150 | +0·569 | +0·363 |
| 165 | +0·834 | +0·209 |
| 180 | +0·923 | +0·135 |

| T/A | A = 0·75 B = 3·25 R | I |
|---|---|---|
| 0 | -1·133 | +0·227 |
| 15 | -1·089 | +0·331 |
| 30 | -0·907 | +0·573 |
| 45 | -0·546 | +0·749 |
| 60 | -0·145 | +0·653 |
| 75 | +0·023 | +0·334 |
| 90 | -0·108 | +0·114 |
| 105 | -0·239 | +0·195 |
| 120 | -0·075 | +0·385 |
| 135 | +0·323 | +0·370 |
| 150 | +0·681 | +0·109 |
| 165 | +0·859 | -0·187 |
| 180 | +0·902 | -0·310 |

| T/A | A = 0·75 B = 3·75 R | I |
|---|---|---|
| 0 | +0·793 | -0·235 |
| 15 | -0·817 | -0·108 |
| 30 | +0·791 | +0·228 |
| 45 | +0·542 | +0·583 |
| 60 | +0·127 | +0·647 |
| 75 | +0·097 | +0·370 |
| 90 | -0·041 | +0·142 |
| 105 | -0·182 | +0·249 |
| 120 | -0·033 | +0·414 |
| 135 | +0·438 | +0·253 |
| 150 | +0·675 | -0·176 |
| 165 | +0·693 | -0·559 |
| 180 | +0·665 | -0·702 |

| T/A | A = 0·75 B = 4·25 R | I |
|---|---|---|
| 0 | -0·277 | -0·627 |
| 15 | -0·377 | -0·516 |
| 30 | -0·547 | -0·165 |
| 45 | -0·488 | +0·320 |
| 60 | -0·113 | +0·564 |
| 75 | +0·164 | +0·360 |
| 90 | +0·028 | +0·137 |
| 105 | -0·113 | +0·279 |
| 120 | -0·152 | +0·407 |
| 135 | +0·509 | +0·099 |
| 150 | +0·551 | -0·437 |
| 165 | +0·368 | -0·819 |
| 180 | +0·263 | -0·940 |

| T/A | A = 0·75 B = 4·75 R | I |
|---|---|---|
| 0 | +0·298 | -0·849 |
| 15 | +0·138 | -0·795 |
| 30 | -0·219 | -0·530 |
| 45 | -0·397 | +0·003 |
| 60 | -0·120 | +0·418 |
| 75 | +0·206 | +0·311 |
| 90 | +0·084 | +0·103 |
| 105 | -0·043 | +0·282 |
| 120 | +0·268 | +0·363 |
| 135 | +0·525 | -0·076 |
| 150 | +0·328 | -0·626 |
| 165 | -0·044 | -0·901 |
| 180 | -0·209 | -0·960 |

CYLINDER RADIUS 1.0 RADIANS (0.16λ)

TANGENTIAL DIPOLE

### A = 1.0  B = 1.5

| T | R | I |
|---|---|---|
| 0 | -0.482 | +0.619 |
| 15 | -0.432 | +0.580 |
| 30 | -0.308 | +0.464 |
| 45 | -0.178 | +0.283 |
| 60 | -0.104 | +0.077 |
| 75 | -0.110 | -0.091 |
| 90 | -0.169 | -0.167 |
| 105 | -0.220 | -0.126 |
| 120 | -0.204 | +0.009 |
| 135 | -0.100 | +0.186 |
| 150 | +0.060 | +0.344 |
| 165 | +0.204 | +0.445 |
| 180 | +0.262 | +0.478 |

### A = 1.0  B = 2.0

| T | R | I |
|---|---|---|
| 0 | -0.953 | +0.819 |
| 15 | -0.867 | +0.805 |
| 30 | -0.644 | +0.734 |
| 45 | -0.379 | +0.562 |
| 60 | -0.195 | +0.300 |
| 75 | -0.164 | +0.040 |
| 90 | -0.251 | -0.096 |
| 105 | -0.329 | -0.052 |
| 120 | -0.277 | +0.121 |
| 135 | -0.063 | +0.308 |
| 150 | +0.232 | +0.421 |
| 165 | +0.478 | +0.454 |
| 180 | +0.572 | +0.456 |

### A = 1.0  B = 2.5

| T | R | I |
|---|---|---|
| 0 | -1.256 | +0.736 |
| 15 | -1.161 | +0.770 |
| 30 | -0.894 | +0.815 |
| 45 | -0.534 | +0.748 |
| 60 | -0.242 | +0.511 |
| 75 | -0.159 | +0.203 |
| 90 | -0.265 | +0.020 |
| 105 | -0.366 | +0.065 |
| 120 | -0.270 | +0.244 |
| 135 | +0.039 | +0.368 |
| 150 | +0.415 | +0.347 |
| 165 | +0.695 | +0.246 |
| 180 | +0.795 | +0.193 |

### A = 1.0  B = 3.0

| T | R | I |
|---|---|---|
| 0 | -1.299 | +0.439 |
| 15 | -1.229 | +0.526 |
| 30 | -0.997 | +0.713 |
| 45 | -0.613 | +0.811 |
| 60 | -0.237 | +0.664 |
| 75 | -0.097 | +0.344 |
| 90 | -0.220 | +0.129 |
| 105 | -0.344 | +0.185 |
| 120 | -0.206 | +0.356 |
| 135 | +0.167 | +0.373 |
| 150 | +0.547 | +0.174 |
| 165 | +0.776 | -0.076 |
| 180 | +0.845 | -0.185 |

### A = 1.0  B = 3.5

| T | R | I |
|---|---|---|
| 0 | -1.062 | +0.023 |
| 15 | -1.048 | +0.147 |
| 30 | -0.934 | +0.455 |
| 45 | -0.613 | +0.737 |
| 60 | -0.194 | +0.730 |
| 75 | +0.005 | +0.434 |
| 90 | -0.132 | +0.204 |
| 105 | -0.275 | +0.284 |
| 120 | -0.095 | +0.439 |
| 135 | +0.298 | +0.324 |
| 150 | +0.593 | -0.052 |
| 165 | +0.688 | -0.420 |
| 180 | +0.695 | -0.564 |

### A = 1.0  B = 4.0

| T | R | I |
|---|---|---|
| 0 | -0.594 | -0.394 |
| 15 | -0.654 | -0.267 |
| 30 | -0.718 | +0.097 |
| 45 | -0.547 | +0.536 |
| 60 | -0.137 | +0.699 |
| 75 | +0.119 | +0.460 |
| 90 | -0.023 | +0.231 |
| 105 | -0.176 | +0.345 |
| 120 | +0.046 | +0.478 |
| 135 | +0.412 | +0.223 |
| 150 | +0.537 | -0.287 |
| 165 | +0.441 | -0.695 |
| 180 | +0.369 | -0.837 |

### A = 1.0  B = 4.5

| T | R | I |
|---|---|---|
| 0 | -0.001 | -0.702 |
| 15 | -0.131 | -0.614 |
| 30 | -0.390 | -0.289 |
| 45 | -0.435 | +0.239 |
| 60 | -0.091 | +0.577 |
| 75 | +0.217 | +0.422 |
| 90 | +0.083 | +0.206 |
| 105 | -0.066 | +0.363 |
| 120 | +0.201 | +0.463 |
| 135 | +0.487 | +0.079 |
| 150 | +0.387 | -0.483 |
| 165 | +0.086 | -0.830 |
| 180 | -0.059 | -0.926 |

### A = 1.0  B = 5.0

| T | R | I |
|---|---|---|
| 0 | +0.582 | -0.823 |
| 15 | +0.408 | -0.808 |
| 30 | -0.013 | -0.621 |
| 45 | -0.300 | -0.105 |
| 60 | +0.079 | +0.386 |
| 75 | +0.274 | +0.335 |
| 90 | +0.162 | +0.138 |
| 105 | +0.035 | +0.339 |
| 120 | +0.345 | +0.393 |
| 135 | +0.509 | -0.093 |
| 150 | +0.164 | -0.605 |
| 165 | -0.299 | -0.788 |
| 180 | -0.488 | -0.801 |

# CYLINDER RADIUS 1·25 RADIANS (0·20λ)

## TANGENTIAL DIPOLE

### A = 1·25  B = 1·75

| T | R | I |
|---|---|---|
| 0 | -0·633 | +0·486 |
| 15 | -0·574 | +0·469 |
| 30 | -0·428 | +0·405 |
| 45 | -0·264 | +0·275 |
| 60 | -0·162 | +0·098 |
| 75 | -0·159 | -0·064 |
| 90 | -0·224 | -0·144 |
| 105 | -0·277 | -0·110 |
| 120 | -0·240 | -0·008 |
| 135 | -0·091 | +0·143 |
| 150 | -0·120 | +0·238 |
| 165 | +0·301 | +0·280 |
| 180 | +0·371 | +0·289 |

### A = 1·25  B = 2·25

| T | R | I |
|---|---|---|
| 0 | -1·126 | +0·580 |
| 15 | -1·038 | +0·600 |
| 30 | -0·799 | +0·614 |
| 45 | -0·499 | +0·535 |
| 60 | -0·274 | +0·331 |
| 75 | -0·225 | +0·088 |
| 90 | -0·320 | -0·048 |
| 105 | -0·405 | -0·006 |
| 120 | -0·329 | +0·146 |
| 135 | -0·068 | +0·268 |
| 150 | +0·269 | +0·280 |
| 165 | +0·534 | +0·220 |
| 180 | +0·632 | +0·185 |

### A = 1·25  B = 2·75

| T | R | I |
|---|---|---|
| 0 | -1·381 | +0·424 |
| 15 | -1·296 | +0·497 |
| 30 | -1·039 | +0·644 |
| 45 | -0·661 | +0·700 |
| 60 | -0·323 | +0·550 |
| 75 | -0·208 | +0·274 |
| 90 | -0·318 | +0·097 |
| 105 | -0·428 | +0·146 |
| 120 | -0·313 | +0·302 |
| 135 | +0·026 | +0·342 |
| 150 | +0·405 | +0·197 |
| 165 | +0·662 | -0·008 |
| 180 | +0·747 | -0·101 |

### A = 1·25  B = 3·25

| T | R | I |
|---|---|---|
| 0 | -1·336 | +0·114 |
| 15 | -1·289 | +0·232 |
| 30 | -1·099 | +0·513 |
| 45 | -0·724 | +0·743 |
| 60 | -0·305 | +0·704 |
| 75 | +0·120 | +0·427 |
| 90 | -0·239 | +0·224 |
| 105 | -0·371 | +0·291 |
| 120 | -0·219 | +0·438 |
| 135 | +0·156 | +0·362 |
| 150 | +0·487 | +0·039 |
| 165 | +0·644 | -0·302 |
| 180 | +0·679 | -0·441 |

### A = 1·25  B = 3·75

| T | R | I |
|---|---|---|
| 0 | -1·001 | -0·247 |
| 15 | -1·018 | -0·110 |
| 30 | -0·970 | +0·257 |
| 45 | -0·690 | +0·653 |
| 60 | -0·240 | +0·760 |
| 75 | +0·014 | +0·515 |
| 90 | -0·109 | +0·299 |
| 105 | -0·256 | +0·395 |
| 120 | -0·066 | +0·527 |
| 135 | +0·297 | +0·320 |
| 150 | +0·490 | -0·154 |
| 165 | +0·474 | -0·571 |
| 180 | +0·433 | -0·726 |

### A = 1·25  B = 4·25

| T | R | I |
|---|---|---|
| 0 | -0·452 | -0·552 |
| 15 | -0·541 | -0·435 |
| 30 | -0·681 | -0·067 |
| 45 | -0·579 | +0·443 |
| 60 | -0·158 | +0·710 |
| 75 | +0·157 | +0·523 |
| 90 | +0·038 | +0·305 |
| 105 | -0·112 | +0·440 |
| 120 | +0·118 | +0·551 |
| 135 | +0·423 | +0·218 |
| 150 | +0·408 | -0·342 |
| 165 | +0·183 | -0·741 |
| 180 | +0·063 | -0·868 |

### A = 1·25  B = 4·75

| T | R | I |
|---|---|---|
| 0 | +0·185 | -0·714 |
| 15 | +0·037 | -0·659 |
| 30 | -0·287 | -0·391 |
| 45 | -0·419 | +0·144 |
| 60 | -0·092 | +0·562 |
| 75 | +0·273 | +0·455 |
| 90 | +0·169 | +0·245 |
| 105 | +0·031 | +0·422 |
| 120 | +0·305 | +0·501 |
| 135 | +0·507 | +0·062 |
| 150 | +0·251 | -0·486 |
| 165 | -0·164 | -0·761 |
| 180 | -0·346 | -0·818 |

### A = 1·25  B = 5·25

| T | R | I |
|---|---|---|
| 0 | +0·762 | -0·689 |
| 15 | +0·590 | -0·723 |
| 30 | +0·136 | -0·646 |
| 45 | -0·240 | -0·191 |
| 60 | -0·065 | +0·343 |
| 75 | +0·333 | +0·333 |
| 90 | +0·254 | +0·134 |
| 105 | +0·146 | +0·351 |
| 120 | +0·463 | +0·383 |
| 135 | +0·528 | -0·127 |
| 150 | +0·042 | -0·558 |
| 165 | -0·492 | -0·617 |
| 180 | -0·694 | -0·576 |

TANGENTIAL DIPOLE

CYLINDER RADIUS 1.5 RADIANS (0.24λ)

| T<br>A = 1.5  B = 2.0 | R | I |
|---|---|---|
| 0 | -0.736 | +0.266 |
| 15 | -0.673 | +0.277 |
| 30 | -0.510 | +0.281 |
| 45 | -0.317 | +0.228 |
| 60 | -0.187 | +0.108 |
| 75 | -0.173 | -0.026 |
| 90 | -0.246 | -0.092 |
| 105 | -0.308 | -0.053 |
| 120 | -0.265 | +0.049 |
| 135 | -0.095 | +0.134 |
| 150 | +0.136 | +0.151 |
| 165 | +0.328 | +0.120 |
| 180 | +0.401 | +0.099 |

| T<br>A = 1.5  B = 2.5 | R | I |
|---|---|---|
| 0 | -1.252 | +0.231 |
| 15 | -1.167 | +0.290 |
| 30 | -0.923 | +0.407 |
| 45 | -0.591 | +0.449 |
| 60 | -0.317 | +0.335 |
| 75 | -0.237 | +0.138 |
| 90 | -0.335 | +0.024 |
| 105 | -0.432 | +0.082 |
| 120 | -0.349 | +0.220 |
| 135 | -0.072 | +0.269 |
| 150 | +0.263 | +0.167 |
| 165 | +0.508 | +0.006 |
| 180 | +0.594 | -0.069 |

| T<br>A = 1.5  B = 3.0 | R | I |
|---|---|---|
| 0 | -1.476 | +0.026 |
| 15 | -1.405 | +0.136 |
| 30 | -1.169 | +0.389 |
| 45 | -0.773 | +0.585 |
| 60 | -0.376 | +0.548 |
| 75 | -0.209 | +0.327 |
| 90 | -0.310 | +0.178 |
| 105 | -0.427 | +0.252 |
| 120 | -0.305 | +0.395 |
| 135 | +0.032 | +0.353 |
| 150 | +0.362 | +0.086 |
| 165 | +0.552 | -0.218 |
| 180 | +0.606 | -0.347 |

| T<br>A = 1.5  B = 3.5 | R | I |
|---|---|---|
| 0 | -1.368 | -0.248 |
| 15 | -1.345 | -0.106 |
| 30 | -1.202 | +0.255 |
| 45 | -0.836 | +0.614 |
| 60 | -0.360 | +0.694 |
| 75 | +0.105 | +0.476 |
| 90 | -0.200 | +0.299 |
| 105 | -0.329 | +0.395 |
| 120 | -0.170 | +0.532 |
| 135 | +0.175 | +0.375 |
| 150 | +0.409 | -0.052 |
| 165 | +0.455 | -0.459 |
| 180 | +0.442 | -0.618 |

| T<br>A = 1.5  B = 4.0 | R | I |
|---|---|---|
| 0 | -0.959 | -0.494 |
| 15 | -1.004 | -0.356 |
| 30 | -1.022 | +0.040 |
| 45 | -0.783 | +0.526 |
| 60 | -0.292 | +0.742 |
| 75 | +0.042 | +0.550 |
| 90 | -0.042 | +0.352 |
| 105 | -0.176 | +0.478 |
| 120 | +0.024 | +0.601 |
| 135 | +0.332 | +0.324 |
| 150 | +0.387 | -0.211 |
| 165 | +0.233 | -0.639 |
| 180 | +0.139 | -0.788 |

| T<br>A = 1.5  B = 4.5 | R | I |
|---|---|---|
| 0 | -0.348 | -0.633 |
| 15 | -0.461 | -0.541 |
| 30 | -0.669 | -0.207 |
| 45 | -0.636 | +0.332 |
| 60 | -0.202 | +0.682 |
| 75 | +0.193 | +0.537 |
| 90 | +0.121 | +0.326 |
| 105 | -0.006 | +0.485 |
| 120 | +0.239 | +0.585 |
| 135 | +0.468 | +0.202 |
| 150 | +0.295 | -0.358 |
| 165 | -0.064 | -0.702 |
| 180 | -0.232 | -0.796 |

| T<br>A = 1.5  B = 5.0 | R | I |
|---|---|---|
| 0 | +0.320 | -0.615 |
| 15 | +0.163 | -0.605 |
| 30 | -0.211 | -0.433 |
| 45 | -0.428 | +0.061 |
| 60 | -0.124 | +0.524 |
| 75 | +0.307 | +0.446 |
| 90 | +0.251 | +0.227 |
| 105 | +0.144 | +0.420 |
| 120 | +0.436 | +0.483 |
| 135 | +0.550 | +0.020 |
| 150 | +0.143 | -0.461 |
| 165 | -0.371 | -0.619 |
| 180 | -0.579 | -0.623 |

| T<br>A = 1.5  B = 5.5 | R | I |
|---|---|---|
| 0 | +0.891 | -0.436 |
| 15 | +0.730 | -0.526 |
| 30 | +0.264 | -0.587 |
| 45 | -0.198 | -0.242 |
| 60 | -0.084 | +0.297 |
| 75 | +0.356 | +0.303 |
| 90 | +0.319 | +0.082 |
| 105 | +0.244 | +0.304 |
| 120 | +0.581 | +0.312 |
| 135 | +0.554 | -0.195 |
| 150 | +0.047 | -0.498 |
| 165 | -0.616 | -0.401 |
| 180 | -0.814 | -0.297 |

CYLINDER RADIUS 1·75 RADIANS (0·28λ)

TANGENTIAL DIPOLE

### A = 1·75  B = 2·25

| T | R | I |
|---|---|---|
| 0 | -0·806 | +0·021 |
| 15 | -0·744 | +0·058 |
| 30 | -0·573 | +0·128 |
| 45 | -0·355 | +0·155 |
| 60 | -0·189 | +0·094 |
| 75 | +0·152 | -0·005 |
| 90 | -0·226 | -0·048 |
| 105 | -0·298 | +0·009 |
| 120 | -0·260 | +0·108 |
| 135 | -0·092 | +0·148 |
| 150 | +0·126 | +0·087 |
| 165 | +0·296 | -0·014 |
| 180 | +0·358 | -0·063 |

### A = 1·75  B = 4·25

| T | R | I |
|---|---|---|
| 0 | -0·878 | -0·671 |
| 15 | -0·954 | -0·548 |
| 30 | -1·054 | -0·162 |
| 45 | -0·883 | +0·376 |
| 60 | -0·370 | +0·679 |
| 75 | +0·049 | +0·527 |
| 90 | +0·021 | +0·340 |
| 105 | +0·077 | +0·499 |
| 120 | +0·150 | +0·628 |
| 135 | +0·398 | +0·313 |
| 150 | +0·302 | -0·230 |
| 165 | +0·005 | -0·616 |
| 180 | -0·145 | -0·738 |

### A = 1·75  B = 2·75

| T | R | I |
|---|---|---|
| 0 | -1·330 | -0·137 |
| 15 | -1·255 | -0·045 |
| 30 | -1·022 | +0·163 |
| 45 | -0·667 | +0·320 |
| 60 | -0·337 | +0·299 |
| 75 | -0·210 | +0·151 |
| 90 | -0·298 | +0·071 |
| 105 | -0·403 | +0·163 |
| 120 | -0·321 | +0·304 |
| 135 | -0·056 | +0·294 |
| 150 | +0·231 | +0·090 |
| 165 | +0·413 | -0·159 |
| 180 | +0·470 | -0·268 |

### A = 1·75  B = 4·75

| T | R | I |
|---|---|---|
| 0 | -0·224 | -0·629 |
| 15 | -0·359 | -0·574 |
| 30 | -0·642 | -0·310 |
| 45 | -0·703 | +0·219 |
| 60 | -0·283 | +0·627 |
| 75 | +0·185 | +0·509 |
| 90 | +0·173 | +0·289 |
| 105 | +0·092 | +0·466 |
| 120 | +0·372 | +0·562 |
| 135 | +0·533 | +0·158 |
| 150 | +0·210 | -0·347 |
| 165 | -0·265 | -0·584 |
| 180 | -0·470 | -0·627 |

### A = 1·75  B = 3·25

| T | R | I |
|---|---|---|
| 0 | -1·517 | -0·365 |
| 15 | -1·468 | -0·228 |
| 30 | -1·271 | +0·106 |
| 45 | -0·876 | +0·423 |
| 60 | -0·419 | +0·492 |
| 75 | -0·184 | +0·327 |
| 90 | -0·257 | +0·213 |
| 105 | -0·369 | +0·329 |
| 120 | -0·242 | +0·481 |
| 135 | -0·064 | +0·379 |
| 150 | +0·306 | +0·017 |
| 165 | +0·388 | -0·355 |
| 180 | +0·395 | -0·507 |

### A = 1·75  B = 5·25

| T | R | I |
|---|---|---|
| 0 | +0·456 | -0·436 |
| 15 | +0·294 | -0·478 |
| 30 | -0·127 | -0·423 |
| 45 | -0·447 | -0·004 |
| 60 | -0·197 | +0·482 |
| 75 | +0·285 | +0·418 |
| 90 | +0·282 | +0·173 |
| 105 | +0·224 | +0·366 |
| 120 | +0·554 | +0·409 |
| 135 | +0·597 | -0·056 |
| 150 | +0·069 | -0·424 |
| 165 | -0·504 | -0·428 |
| 180 | -0·721 | -0·365 |

### A = 1·75  B = 3·75

| T | R | I |
|---|---|---|
| 0 | -1·348 | -0·568 |
| 15 | -1·356 | -0·418 |
| 30 | -1·280 | -0·012 |
| 45 | -0·948 | +0·446 |
| 60 | -0·425 | +0·629 |
| 75 | -0·087 | +0·463 |
| 90 | -0·137 | +0·313 |
| 105 | -0·245 | +0·450 |
| 120 | -0·070 | +0·598 |
| 135 | +0·229 | +0·388 |
| 150 | +0·333 | -0·099 |
| 165 | +0·240 | -0·527 |
| 180 | +0·171 | -0·687 |

### A = 1·75  B = 5·75

| T | R | I |
|---|---|---|
| 0 | +1·001 | -0·130 |
| 15 | +0·858 | -0·271 |
| 30 | +0·392 | -0·471 |
| 45 | -0·161 | -0·257 |
| 60 | -0·138 | +0·268 |
| 75 | +0·322 | +0·281 |
| 90 | +0·323 | +0·021 |
| 105 | +0·292 | -0·226 |
| 120 | +0·664 | +0·196 |
| 135 | +0·567 | -0·295 |
| 150 | -0·103 | -0·439 |
| 165 | -0·654 | -0·171 |
| 180 | -0·827 | -0·002 |